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Endoscopic transsphenoidal surgery of skull base tumors (7514 cases): 25-year experience, evolution of surgical views

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Background. Currently, pituitary adenomas, also known as neuroendocrine pituitary tumors, are one of the most common intracranial tumors in adults, accounting for up to 15 % of all tumors of the central nervous system. Transsphenoidal removal using endoscopic or microscopic surgery remains the main and the most widely used method for their treatment. However, some questions remain regarding the optimal surgical technique and the reducing of complications incidence.

Aim. To analyze the features of endoscopic transsphenoidal access in tumors of the chiasmal sellar region as well as surgical complications and strategies for their prevention and treatment; also this article describes the latest technical developments in this field and the issues identifications requiring constant and future development.

Materials and methods. The technique of transsphenoidal endoscopic removal of chiasmal sellar tumors is described as well as the structure of this approach complications, methods of their prevention and treatment are analyzed based on personal experience over the past 25 years and the experience of foreign colleagues.

Results. A variety of medical and surgical complications may occur after endoscopic transsphenoidal surgery, but it is important to note that their number has been steadily decreasing over the past decade. So, if in our first series of endoscopic operations the percentage of postoperative relapses was 26 %, complications – 7.8 %, mortality – 2.1 %, then gradually the recurrence rate was 9–11 %, complications – 2–7 %, and mortality is approaching zero, now accounting to 0.12 % in the total series. The operation time has also significantly decreased from 1.5–3 hours with the first endoscopic surgeries to 15–25 minutes in the modern period.

Conclusion. In pituitary tumors surgery, the introduction of endoscopic techniques has allowed to solve the main problem of transsphenoidal operations – to expand the overview and lighting of the surgical field as well as to detail the structures of the chiasmal sellar region and to perform the selective intervention. The analysis of all errors and complications, the dynamics of the learning curve allows us to conclude that the development of transsphenoidal endoscopic surgery should be carried out in a large specialized center with extensive experience in such interventions, and the first surgeries should be performed by a training surgeon only with the mandatory assistance of an experienced specialist.

Keywords: transnasal endoscopic surgery, transsphenoidal endoscopic surgery, pituitary adenoma, skull base tumor, complication of transsphenoidal endoscopic surgery

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BACKGROUND

Currently, pituitary adenomas, also known as neuroendocrine pituitary tumors, are one of the most common intracranial tumors in adults, accounting for up to 15 % of all tumors of the central nervous system [1]. Transsphenoidal removal using endoscopic or microscopic surgery remains the main and the most widely used method for their treatment. [2]. However, some controversy remains regarding the optimal surgical technique.

Over the last 2 decades, there has been a gradual shift from the routine microscopic approach to endoscopic endonasal approach for pituitary adenomas surgery [3]. An overall reduction of complications incidence has been stated compared to similar microsurgical series reported previously [4, 5]. Moreover, this approach has allowed to increase the tumor resection volume, especially in cases of large or giant pituitary adenomas and recurrent disease, particularly in patients who have already

undergone surgery using a microsurgical transsphenoidal approach [6, 7].

However, as the range of approaches to the skull base expanded, the relevance of the main problem of endonasal surgery increased – the risk of postoperative liquorrhea with associated dangerous complications. Currently, the reconstruction of the skull base defect has become a fundamental stage of transnasal endoscopic surgery with various reconstruction methods available – from the using of free tissue plasty to vascularized flaps.

Aim – to analyze the features of endoscopic transsphenoidal access for chiasmal sellar region (ChSR) tumors as well as surgical complications and strategies for their prevention and treatment. Also, this article describes the latest technical developments in this field and the issues identifications requiring constant and future development.

MATERIALS AND METHODS

Over the past 25 years, we have operated on more than 7,500 patients using the endoscopic endonasal transsphenoidal technique (Table 1). All operations were performed by essentially one surgical team using the same standards and technique. Certainly, over such a period, the surgeon's views are transformed, some nuances of actions disappear and become a thing of the past with some new techniques appear. With the accumulation of experience, the implementation of new materials and their intraoperative analysis, there is a natural optimization of the tumor removal stages and sealing of skull base defects. Over the past 10–15 years, we have operated on about 320–350 patients with ChSR tumors.

The main characteristics of this patients group are presented below. The age of the patients ranged from 2 to 89 years old (median 47.5); 218 endoscopic operations were performed in children. The male to female ratio was 1:1.45.

Among the operated patients, the main nosological group was patients with pituitary adenomas. The tumor was endosellar in 948 (15 %) patients, in the remaining 85 % of cases, the extrasellar growth was noted; microadenomas accounted for 13 %; almost half (48 %) of the adenomas were large (>3 cm) and giant (>5 cm) in size (Table 2).

We classified giant pituitary adenomas as tumors whose maximum size exceeded 5 cm. There is considerable discussion in the world literature on the issue of which adenomas should be considered as giant. A number of authors consider tumors of various sizes, sometimes even from 2 cm, to be giant, but the most agree that these are tumors from 4 to 6 cm.

Although in general such a division is rather arbitrary, our study showed that with tumors from 5 cm in size, the number of postoperative complications in operated patients statistically significantly increases sharply and the radicality of removal is significantly lower compared to smaller size tumors. In this regard, we believe it is correct to distinguish a group of giant adenomas of precisely from 5 cm.

Table 1. Distribution of the patients who underwent surgery according to nosologic units

Nosology	Number of patients, *n* (%)
Pituitary adenoma	6320 (84,1)
Craniopharyngioma	389 (5,2)
Meningioma	139 (1,8)
Pituitary colloid cyst	118 (1,6)
Chordoma	119 (1,6)
Schwannoma	24 (0,3)
Chondroma	29 (0,4)
Cholesteatoma	112 (1,5)
Choristoma	7 (0,1)
Angioreticuloma	4 (0,05)
Cylindroma	12 (0,2)
Mucosal cancer	93 (1,2)
Pituitary metastases	32 (0,4)
Osteoma	19 (0,3)
Isolated cerebrospinal fluid cyst	48 (0,6)
Other	49 (0,7)
Total	*7514 (100)*

Table 2. Distribution of pituitary adenomas in operated patients according to tumor size

Type of adenoma	Number of cases, *n* (%)
Microadenoma (<10 mm)	820 (13)
Endocellar adenoma (10–15 mm)	126 (2)
Mesoadenoma (10–30 mm)	2344 (37)
Large adenoma (30–50 mm)	1641 (26)
Giant adenoma (>50 mm)	1389 (22)
Total	*(100)*

Table 3 presents the data about pituitary tumors in operated patients depending on their hormonal activity: among them there were lesions secreting somatotropic hormone (16.3 %), prolactin (5 %), adrenocorticotropic hormone (10.9 %), thyroid-stimulating hormone (0.71 %); less than 1 % were tumors of mixed secretion and plurihormonal adenomas; hormonally inactive tumors accounted for 63.9 %.

In all cases of hormonally active tumors, the clinical manifestations were represented by hyperproduction of pituitary tropic hormones. In addition, 81 % of patients had neurological symptoms in the form of headaches, 66 % of patients had visual disturbances, namely chiasmal syndrome, and 4.5 % had oculomotor disturbances. Besides, a number of patients had hemiparesis, diencephalic and brainstem disturbances.

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Table 3. Distribution of pituitary adenomas in operated patients according to hormonal secretion

Type of adenoma	Number of cases, *n* (%)
HGH-secreting	1032 (16,3)
ACTH-secreting	689 (10,9)
TSH-secreting	45 (0,7)
PRL-secreting	318 (5,0)
Mixed HGH-PRL-secreting	59 (0,9)
Plurihormonal	25 (0,4)
Gonadotropinoma	24 (0,4)
Non-secreting	4041 (63,9)
Oncocytoma	87 (13,8)
Total	*6320 (100)*

Note. *HGH – human growth hormone; ACTH – adrenocorticotropic hormone; TSH – thyroid-stimulating hormone; PRL – prolactin.*

We used the endoscopic endonasal approach (Fig. 1) to the sella turcica, which we described earlier (V.Yu. Cherebillo et al., 1998, 2001, 2005, 2008) [8–12].

In the majority of cases (93 %), we used a unilateral endonasal endoscopic approach through 1 nasal passage. The access side was selected depending on the width of the nasal passages. All other things being equal, a right-handed surgeon chose the left approach, which was more physiological and convenient. Summarizing, 91 % of surgical interventions were performed through the left nasal passage and 9 % – through the right.

At the nasal stage, we performed endoscopic access to the sphenoid sinus. We used an nasal speculum in 91 % of cases, which, in our opinion, is optimal for this surgery (Fig. 2). The advantages of the nasal port include a statistically significant reduction in the operation time (the average duration of the operation without a port was 33.4 minutes, and with a nasal speculum – 21.2 minutes), as well as a significant reduction in postoperative endonasal inflammatory complications.

The portless surgery with constant multiple intraoperative movements of instruments often leads to additional trauma of the nasal mucosa and nasal speculum, which in the delayed period increases the likelihood of developing the postoperative sphenoiditis, sinusitis, and synechiae, which worsen the quality of patients' life. In the group of patients operated without a nasal speculum, the frequency of postoperative inflammatory changes in the nasal cavity was 6.8 %, and in the group using a nasal speculum – 2.9 %. The reducing the time of surgery and the complications frequency reducing led to the fact that we constantly use a nasal speculum in routine practice.

The disadvantages of using a nasal speculum include the limitation of the amplitude of movements in lateral directions, which is not often required in standard adenomectomy. In the case of a significant laterosellar tumor node, it is easier to remove the main tumor node while using a nasal speculum, and when temporarily remove it if there is a need for manipulations on the lateral sections. In our series of observations, it was required in 6 % of cases. From our point of view, this technique is optimal.

The main stage of tumor removal (Fig. 3) is performed under the control of a 0° endoscope. When removing a tumor from the suprasellar, parasellar, and sometimes retrosellar spaces, it becomes necessary to sequentially use 30°, 45° and 70° endoscopes. This is especially important in the case of antesuprasellar tumor growth, as well as when removing the secondary tumor nodes extending from its suprasellar section, and from the upper sections of the cavernous sinuses. With an endoscope, it is almost always possible to find the entrance to the secondary tumor node and radically remove it.

For hemostasis in the cavity of the removed tumor and in the sinus, we use Surgicel Fibrillar (Fig. 4, *a*). The texture and hemostatic properties of this material, in our opinion, are optimal for endoscopic surgery. All other available means for local hemostasis such as hemostatic gauze and sponge, cotton wool with hydrogen peroxide and various powders from many manufacturers, as well as drop agents are lower in their hemostatic functions to materials based on oxidized regenerated cellulose.

In addition, the low pH of these agents reduces the likelihood of inflammatory complications. In some cases, an additional good effect can be achieved by using Floseal (Baxter) or Surgiflo with thrombin (Ethicon) (Fig. 4, *b*).

In the case of liquorrhea, the postoperative defect of the sella cavity was sealed using autologous tissues, Tachocomb plates (Fig. 4, *c*) and various fibrin-thrombin adhesive compositions (Tissucol or Evicel). Ideally, even if there is no intraoperative liquorrhea, the sella bottom should be sealed in all cases, but the peculiarities of surgical material supplement do not always allow this, so sealing in the absence of liquorrhea is always an intraoperative decision of the surgeon. In real conditions, with pronounced sagging of the sella diaphragm, we considered the sealing is mandatory, and if the sella diaphragm was covered by the pituitary gland and there were no provoking factors, then we refrained from it. In the presence of liquorrhea, the sealing of sella cavity defect is mandatory.

RESULTS

The results of surgical treatment were assessed using the standard indicators: dynamics of the main clinical syndromes (neuro-ophthalmological symptoms, neurological and hormonal status), radicality of the operation, frequency and nature of complications as well as postoperative mortality.

The improvement of visual functions after surgery was noted at discharge in 76 % of the operated patients who had

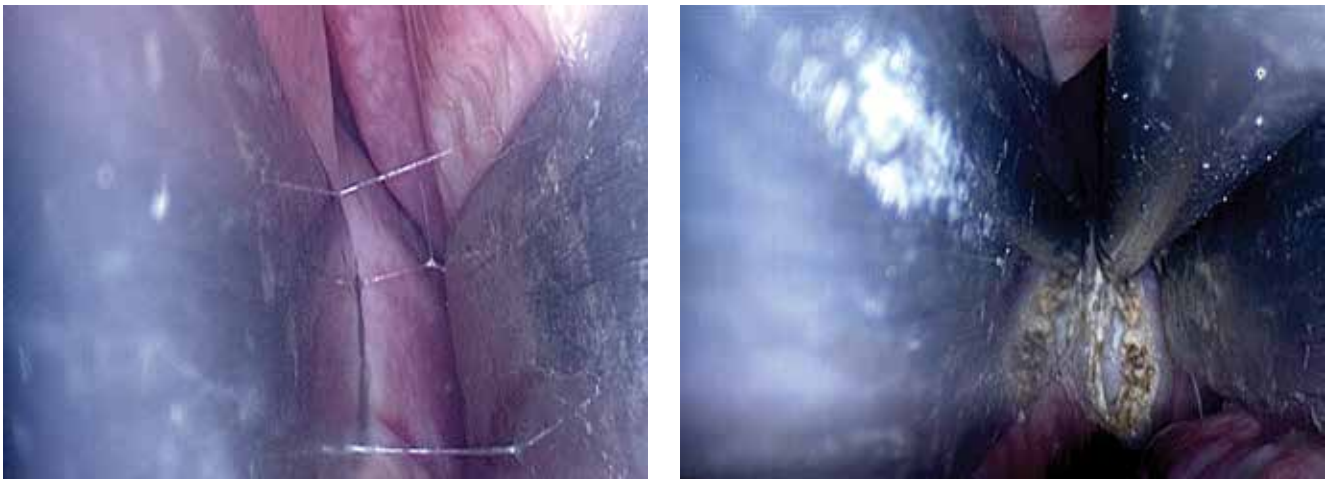

Fig. 1. *Initial stages of surgical access to the sphenoid sinus*

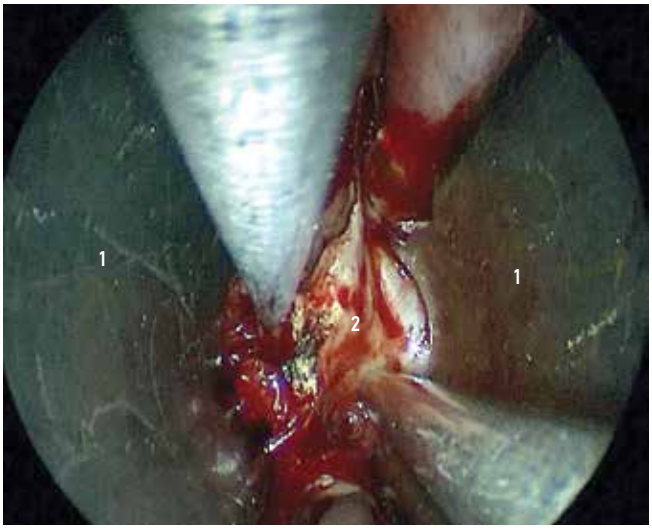

Fig. 2. *The initial stage of access to the sphenoid sinus; rostrum resection.1 – branches of nasal speculum; 2 – rostrum*

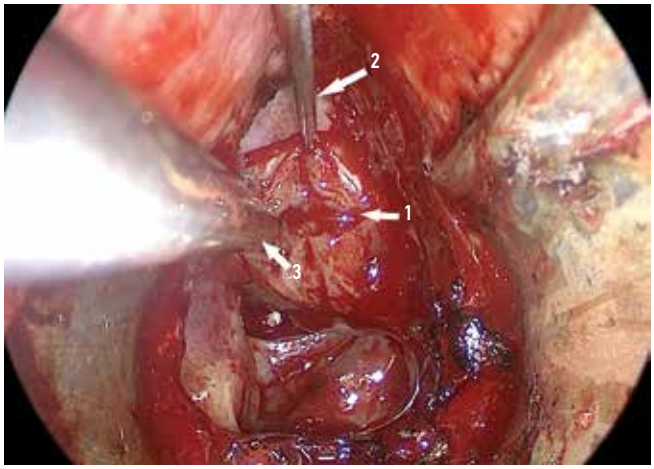

Fig. 3. *Dura mater opening and tumor resection stage. 1 – tumor tissue; 2 – microsurgical scalpel; 3 – aspirator*

visual impairments before surgery. The deterioration of visual functions after surgery was recorded in 1.2 % of the patients. The oculomotor impairments at discharge regressed in 64 % of the operated patients who had them before surgery. In the delayed period, the regression rate reached 98 %. The increase of oculomotor impairments was observed after surgery in 1 patient, which regressed during follow-up period.

According to the results of hormonal status examination in patients with elevated preoperative levels of pituitary tropic hormones, the normalization of insulin-like growth factor 1 and somatotropic hormone levels after surgical treatment was achieved in 783 (75.8 %) of 1032 cases of somatopropinomas. A clear correlation was noted between the dependence of achieving thehormonal remission in somatotropinomas and the degree of invasion according to Knosp. The absolute majority of patients who did not achieve hormonal remission had III–IV degree of invasion according to the Knosp scale.

The total tumor removal according to magnetic resonance imaging (MRI) data is not always accompanied by complete hormonal remission. Probably, with an invasive nature of growth, microfragments of the lesion remain in the cavernous sinus, which are not visible and are beyond the resolution of MRI, and sometimes the lesion is multifocal and removal of a larger manifest fragment does not always lead to recovery of the patient.

In prolactinomas resistant to conservative treatment, the remission after surgery was achieved in a smaller number of observations (in 167 of 318 patients, which amounted to 52.5 %) and also clearly correlated with the degree of invasion into the cavernous sinus.

Among 689 corticotropinomas analyzed, the normalization of corticotropin level was seen in 584 (84.7 %) patients. Our results are not inferior to those of the world's leading endoscopic neurosurgeons. For

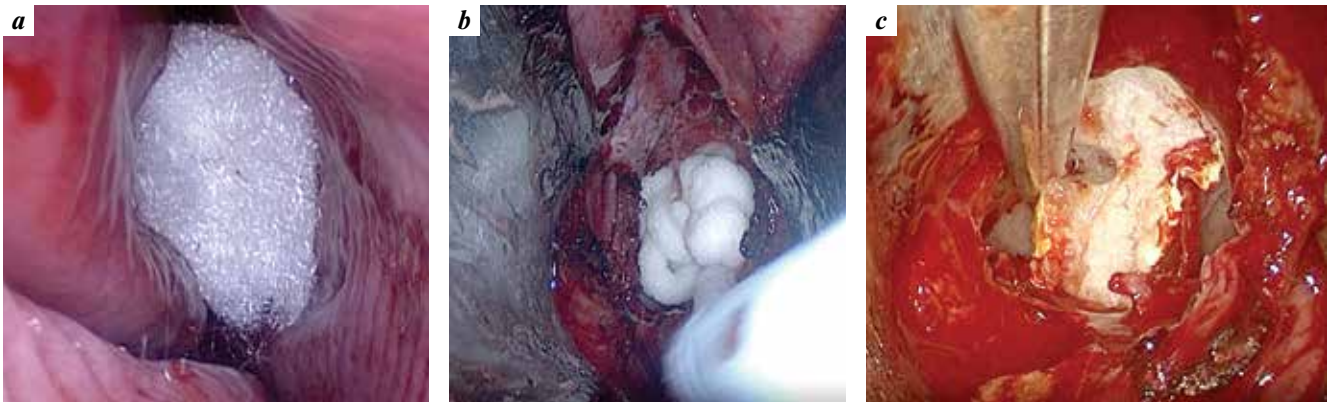

Fig. 4. *Hemostasis and cerebrospinal fluid stasis stage: a – Surgicel Fibrillar is placed into the cavity of the resected tumor; b – cavity of the resected tumor is filled with hemostatic matrix Surgiflo; c –hemostasis and cerebrospinal fluid stasis using TachoComb plates*

example, in a series of observations by P. Cappabianca et al., the normalization of corticotropin level was seen in 73.6 % of patients [5, 7].

The appearance or increase of preoperative anterior pituitary insufficiency (complete or partial hypopituitarism, hypothyroidism, hypogonadism and/or hypocorticism) occurred in 5.6 % of patients. The development of diabetes insipidus in the postoperative period (which indicates the damage of neurohypophysis or pituitary stalk) was noted in 1.3 % of patients with pituitary tumors.

Among all the operated patients, the total removal according to control MRI data was achieved in 92.3 % of cases, subtotal and partial – in 7.7 %. The scheme we used to assess the radicality of the operation is similar to that used by local and foreign authors [3, 4, 6, 13].

We considered the tumor removal as total when, according to the surgeon's intraoperative opinion and postoperative MRI data, there were no tumor remnants. With total removal of a hormonally active tumor, the elevated preoperative hormone level should be also normalized.

We considered the tumor removal as subtotal when the volume of the unremoved lesion part did not exceed 20 % of the baseline volume, and also when, according to postoperative MRI data, no obvious tumor remnants were revealed, but the normalization of the elevated preoperative hormone levels in the blood could not be achieved. The cases of partial removal accounted for about 1 % and included those observations when less than 80 % of the primary adenoma volume was removed during surgery.

The frequency of transsphenoidal endoscopic surgery complications was 1.9 %. The most common and potentially dangerous postoperative complication of transsphenoidal surgery was nasal cerebrospinal fluid (CSF) leakage (nasal liquorrhea). In our series of observations, the postoperative nasal liquorrhea developed in 1.2 % of patients. The incidence of postoperative meningitis was 0.2 %.

When postoperative nasal liquorrhea was detected, we divided patients into 2 groups. If during the main operation the surgeon performed the sealing of the bottom of sella and it turned out to be inconsistent, then the lumbar drainage was placed for 3–5 days with the CSF evacuation of 4–6 ml per hour (100–150 ml per day). As a rule, such strategy made possible to stop liquorrhea in the overwhelming majority of cases.

Only in 3 cases, the use of lumbar drainage was insufficient and repeated surgical correction of skull base sealing was required. If during the first operation there was no intraoperative liquorrhea and skull base sealing was not performed, then we tried to perform the repeated intervention as soon as possible, without waiting for possible development of inflammatory changes in the CSF. The aim of the repeated surgery was to find a liquor fistula and seal it using various allo- and automaterials.

The preference was given to autologous tissues (local tissues of the nasal septum, fragments of the mucous membrane of the sinus and turbinate, autologous fat, sometimes mucoperiosteal flap), necessarily using additional Tachocomb plates and various fibrin-thrombin adhesive compositions (Tissucol or Evicel).

The postoperative meningitis was relatively rare, its frequency was 0.2 % of the total number of patients, and in the group with pituitary adenomas – 0.1 %. The strategy for treating the postoperative meningitis do not have the features typical for endoscopic interventions – antibacterial therapy is prescribed depending on the sensitivity of the pathogen to a particular antibiotic revealed during microbiological testing.

One of the most dangerous complications is damage of the intracavernous part of the internal carotid artery (ICA) or rupture of the inferior pituitary artery during removal of the laterosellar tumor fragment. In total, in our series of observations, 6 cases of ICA damage were noted. In 1 case, the ICA damage led to the formation of a carotid-cavernous fistula.

We have published this observation in separate paper [14]. We mistakenly interpreted a large endosellar aneurysm as a craniopharyngioma and damaged the aneurysm during access in 1 clinical case [15]. In the remaining 4 observations,

the branches of the ICA were damaged during manipulation in the cavernous sinus cavity with parasellar tumor growth.

In all cases, after temporary tamponade and hemostasis, the patient, who was under general anesthesia, was transferred to the endovascular operating room, and vascular surgeons sealed the ICA rupture (by stenting in 4 cases or by occluding the ICA with a balloon in 2 cases). In 1 case, the embolization of the false aneurysm with microcoils was additionally used. All patients survived, 5 of them were discharged without neurological deficit, in 1 case at discharge there was paresis of the abducens nerve, which regressed later.

The mortality rate in endoscopic endonasal transsphenoidal operations in our series of observations was 0.12 % (9 patients). In most cases (4 patients), death was caused by secondary ischemic damage of the hypothalamus after removal of giant pituitary adenomas; in 1 case, the severe vasospasm with secondary ischemia developed after subarachnoid hemorrhage.

In another 2 cases, the cause of death was pulmonary embolism, in 1 case – a non-operative hemorrhagic stroke in the early postoperative period in the territory of posterior cerebral artery, and in another case – perioperative somatic decompensation with the development of heart failure in an 84-year-old female patient.

DISCUSSION

Firstly, the neurosurgical approaches to the chiasmal sellar region were quite traumatic and deforming. Recently, with the introduction of the minimally invasive neurosurgery concept, surgical approaches have become more precise, narrow and effective. This has arisen an interest in finding the new innovative trajectories that could provide a more direct route to the pituitary gland without extensive craniotomy and manipulations with brain tissue as well as vascular and nerve structures. The usage of the nasal and paranasal cavities to approach the chiasmal sellar region has become a real revolution. However, any innovation has its own technical features, disadvantages and surgical complications.

Despite a significant reduction in the overall incidence of complications after transsphenoidal endoscopic surgery of pituitary adenomas compared to the microsurgical technique which are still used in some centers, according to foreign literature, the dysfunction of the hypothalamic-pituitary system still remains an actual problem [13].

A.S. Little et al. conducted a prospective, non-randomized, controlled trial involving 7 pituitary surgery centers and 15 highly specialized surgeons who used a microscope or endoscope to resect non-secreting pituitary adenomas. The usage of an endoscope demonstrated significantly lower rates of adrenal insufficiency in the postoperative period compared with interventions using a microscope (18.6 % *versus* 3 %; p <0.001) [13].

One of the manifestations of endocrine dysfunction is a disturbance of water-electrolyte balance caused by changes in the secretion of antidiuretic hormone by the posterior pituitary gland. Although the exact mechanism of these hormonal disturbances as a result of surgery in the ChSR is not fully understood, it is assumed that surgical manipulations in this area and traction of the pituitary stalk lead to trauma that mechanically disrupts the physiological release of antidiuretic hormone reserves.

In the earliest postoperative period and during the first 48 hours after surgery, central diabetes insipidus, caused by impaired release of antidiuretic hormone and, as a consequence, decreased resorption of free water, leads to polyuria, polydipsia and hypernatremia. According to the foreign literature data, the incidence of diabetes insipidus ranges from 0.3 to 45 %, which is partly due to contradictory definitions, different observation intervals, inclusion of different pituitary pathologies and different experience of surgeons reporting it.

Recently, 2 groups of experienced transsphenoidal surgeons who used conventional definitions of diabetes insipidus and whose surgical experience was primarily focused on endoscopic transnasal removal of pituitary adenomas published their own data on the development of postoperative diabetes insipidus with fairly comparable results [16, 17].

In two studies that included data from 178 and 271 patients, the incidence of transient diabetes insipidus was 26 % and 16.6 % respectively, with the transient form becoming permanent in 10 % and 4 % of cases respectively. Based on the results obtained, the authors concluded that patients with large tumors (>1 cm) with a suprasellar direction of their growth are at higher risk of developing diabetes insipidus [16, 17].

According to the data presented in the thesis work of N.I. Mikhailov, devoted to the study of complications after endoscopic endonasal transsphenoidal removal of pituitary adenomas, the severe hypernatremia (>150 mmol/l) was observed in 5.7 % of patients operated on at the Burdenko National Medical Research Center of Neurosurgery for pituitary adenoma (n = 3497) [18].

Among the risk factors for hypernatremia, the author highlights the presence of secondary tumor nodes, hypersecretion of adrenocorticotropic hormone, hydrocephalus, giant size and increased bleeding tendency of the tumor and postoperative hemorrhagic complications. The hyponatremia (a decrease in the sodium level <135 mmol/l) in the postoperative period was detected in 6.5 % of cases in the studied group of patients. The risk factors for hyponatremia are the same as for reverse electrolyte imbalance.

The nasal CSF leakage remains one of the most common surgical complications of transnasal surgery and it is reported to occur in ~3 % of cases in high-volume surgery centers. B.A. Strickland et al. reported that the incidence of postoperative CSF leakage was 2.6 % (26 patients) in a review of 1002 endoscopic transnasal resections of pituitary adenomas [19].

According to statistical data, eight of these patients required reoperation and revision using fat or fascial grafts, while the remaining 16 patients underwent either temporary or multiple lumbar drainage. In contrast, in another series of studies involving 665 patients, V. Sciarretta et al. reported about 8 % incidence of nasal CSF leakage after primary sealing surgery of CSF fistulas [20]. Probably, in this regard, the authors actively encourage the use of a multilayer technique, using fat, lateral thigh fascia, autogenous bone, and mucous membrane in case of unsuccessful sella reconstruction.

The minimal invasiveness of the transnasosphenoidal approach makes it the choice method for treating many skull base lesions. When we began to learn the transsphenoidal approach in 1996 and performed the first purely endoscopic surgeries in Russia, we relied on the capabilities of this approach in treating small pituitary adenomas. Subsequently, with the improvement of endoscopic skills, the indications for using this approach in surgery for both pituitary adenomas and other basal extracerebral tumors expanded significantly.

The development and implementation of endoscopic technologies in transsphenoidal surgery of ChSR tumors has made it possible to solve the main problem of endonasal microsurgical approaches – the lack of a wide panoramic view of the surgical field. The main value of using an endoscope in transsphenoidal surgery is that the endoscope field of view is not limited by a tube, as is in the case with a microscope.

The lightening through the endoscopy is better; the magnification achieved by bringing the endoscope tube closer to the surgical field is higher due to the endomicroscopy effect than when using a microscope; and the panoramic view provided by the endoscope allows identification of all key anatomical points, which minimizes the possibility of losing the necessary access trajectory.

This allows to reduce the damage risk of pituitary gland, blood vessels and nerves, as well as other major anatomical structures; to remove the tumor as radically as possible, including from hard-to-reach places, promptly identify intraoperative CSF leakage and reliably close the defect at the skull base.

While improving the endoscopic techniques and surgical experience, it became possible to operate on the adenomas of any size as well as to perform endoscopic interventions on craniopharyngiomas, cholesteatomas, chordomas, chondromas and other neoplasms of the skull base. The transseptal transsphenoidal endoscopic approach, which was practiced in the late 1990s, gave way to the endonasal endoscopic approach.

At a certain stage, the usage of an electron-optical converter and endolumbar oxygen administration for better contrasting of the upper pole of the tumor were relevant. The usage of endoscopic cryodestruction of ChSR neoplasms was considered promising. However, these methods gradually lost their relevance in the future. An analysis of their use showed that, while allowing one to gain an advantage in one thing, they had disadvantages in another and did not provide an opportunity to achieve strategic superiority.

Nowadays, the methods of extended endoscopic approaches are being improved for surgical treatment of complex cases of giant and widespread tumors, which allow removing almost any neoplasm of the skull base. and if in our first series of endoscopic operations the frequency of postoperative relapses was 26 %, complications – 7.8 %, and mortality – 2.1 %, then gradually the frequency of relapses decreased to 9–11 %, complications – to 2–7 %, and mortality is approaching zero, now accounting to 0.12 % in the general series. The duration of the operation has also significantly decreased – from 1.5–3 hours during the first endoscopic interventions to 15–25 minutes in the modern period.

In conclusion, a variety of medical and surgical complications may occur after endoscopic transsphenoidal surgery, but their incidence has been steadily decreasing over the past decade. Patients with comorbidities or with large and complex parasellar tumors are more prone to developing potential complications and, therefore, should be closely monitored. The safe management of electrolyte disturbances and hypopituitarism requiring replacement therapy is possible in the perioperative period and during long-term follow-up through close collaboration with endocrinologists.

Skull base sealing techniques have improved significantly over the last decade, and the risk of postoperative liquorrhea can be both reduced and eliminated if necessary. A rare but dangerous complication that causes significant morbidity is ICA injury. Understanding the anatomical and technical nuances and careful surgical technique are important to prevent this consequence of transsphenoidal surgery.

Currently, the indications for transsphenoidal approach have been significantly expanded. In particular, it has become possible to transnasally remove the tumors with small sizes of the sella turcica as well as effectively remove tumors with secondary, including non-capsular, nodes and tumors with a narrow isthmus between its upper and basal parts, and also giant tumors.

CONCLUSION

The introduction of endoscopic techniques in the surgery of pituitary tumors, has made it possible to solve the main problem of transsphenoidal operation such as to expand the view and lightening of the surgical field as well as to detail the structures of the pituitary gland in order to perform selective intervention.

An analysis of errors and complications, the dynamics of the learning curve allows us to conclude that the development of transsphenoidal endoscopic surgery should be carried out in a large specialized center with extensive experience in such operations, and the first interventions should be performed by a training surgeon only with the mandatory assistance of an experienced specialist.

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