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Surgical Stratefies for Sellar Tumors Emphasis on Transcranial Access

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Abstract Tumors of the sellar and suprasellar regions represent a significant neurosurgical challenge due to their complex anatomical relationships and potential for endocrine, visual, and neurological complications. Advances in microsurgical anatomy and skull base surgery have significantly expanded the understanding of this region and the available surgical corridors [1]. While endoscopic endonasal approaches have become widely adopted for the treatment of many pituitary and suprasellar tumors, transcranial approaches continue to play a crucial role in the management of large, invasive, or atypically located tumors that extend beyond the limits of endonasal exposure [2–4]. In such cases, transcranial surgery provides wider visualization and safer manipulation of critical neurovascular structures [5]. This study analyzes the clinical outcomes of 382 patients with sellar region tumors treated at the Republican Specialized Scientific and Practical Medical Center of Neurosurgery (Uzbekistan) between 2016 and 2023. Patients were divided into five groups according to the type of transcranial approach used: transcallosal, transcortical transventricular, subfrontal, pterional, and bifrontal (including a modified bifrontal technique). Similar classifications of transcranial routes have been described in previous surgical series addressing complex sellar and suprasellar tumors [6,7]. The analysis demonstrated that transcranial approaches provide broader surgical access and allow subtotal or total tumor resection in selected cases, particularly for giant pituitary adenomas and craniopharyngiomas with significant suprasellar, parasellar, or third ventricular extension [8,9]. These findings are consistent with reports emphasizing the continued relevance of transcranial surgery for tumors with firm consistency, vascular encasement, or irregular growth patterns [10]. Complication profiles varied by approach. Bifrontal and pterional craniotomies achieved higher resection rates in large and complex tumors but were associated with increased risks of diencephalic dysfunction and postoperative endocrine disorders. Similar complication patterns have been reported in comparative studies of transcranial versus transsphenoidal surgery [11,12].

Keywords Sellar region tumors, Transcranial approach, Suprasellar tumors, Pituitary adenoma, Craniopharyngioma, Neurosurgery, Surgical outcomes, Bifrontal craniotomy, Pterional approach, Uzbekistan

1. Introduction

Tumors of the sella turcica and suprasellar region represent a complex interdisciplinary problem requiring collaboration between neurosurgeons, endocrinologists, and radiologists. The choice of surgical approach depends on tumor size, growth pattern, invasiveness, and relationship to surrounding neurovascular structures [3,5]. Over the past century, transsphenoidal surgery has become the preferred approach for most pituitary adenomas due to its lower morbidity and favorable endocrine outcomes [13,14]. The development of fully endoscopic endonasal techniques has further expanded surgical indications and reduced complication rates [15]. Despite these advances, transcranial approaches remain indispensable in selected cases. Large, invasive tumors with lateral, posterior, or superior extension, as well as lesions with dense fibrous consistency or encasement of major vessels, may not be safely or completely resected via an endonasal route [2,6,10]. In such situations, transcranial access provides superior control over the optic apparatus, hypothalamus, and major cerebral arteries. The goals of surgical treatment of sellar and suprasellar tumors include elimination of mass effect, normalization of pituitary hypersecretion, preservation or restoration of pituitary function, prevention of recurrence, and acquisition of tissue for histopathological analysis [4,9]. For these reasons, mastery of both transsphenoidal and

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transcranial techniques remains essential for neurosurgeons specializing in pituitary and skull base surgery [7,11].

The Purpose. This topic is to examine in detail the indications, advantages, and limitations of transcranial approaches, as well as the need to compare their effectiveness in modern neurosurgical interventions.

2. Material and Methods of Research

The study is based on the results of observations of 382 patients with tumors of the sella turcica region who were hospitalized at the Republican Specialized Scientific and Practical Medical Center for Neurosurgery of the Ministry of Health of the Republic of Uzbekistan between 2016 and 2023. The patients' ages ranged from 7 to 62 years. There were 59 males (45%) and 72 females (55%). The observation period ranged from 6 months to 5 years. The average age of patients at the time of the initial surgery was 33.5 years. All patients underwent a full range of diagnostic tests, including clinical neurological, clinical paraclinical, clinical instrumental, and clinical laboratory examinations. The clinical diagnosis was verified using overview and targeted craniography, as well as neuroimaging methods such as computed tomography (CT) or magnetic resonance imaging (MRI) of the brain. The individual characteristics of the tumors in the sellar region were studied in all patients, and additions were made to the existing indications for selecting the most optimal transcranial access. In addition, preoperative preparation was developed for each patient in accordance with the selected transcranial access. According to the primary surgical approach used, patients were divided into 5 groups:

Group I. Transcallosal access. Used as the primary access due to fewer complications. Provides good visualization of the ventricular system. A possible disadvantage of this method is the need for frontal lobe traction, which can sometimes lead to damage to the brain tissue. This access was performed in 55 patients.

Group II. Transcortical transventricular access. Provides the best visualization of the Monroe foramen due to a more lateral approach, which creates better conditions for tumor removal. It is most preferable for large tumors and severe hydrocephalus. The disadvantage of this method is increased seizure activity in the postoperative period. This approach was used in 53 patients.

Group III. Subfrontal access is used for the surgical treatment of voluminous and invasive tumors of the sellar and suprasellar regions, especially when they spread to the anterior parts of the cranial fossa. It provides a direct view of the chiasmal-sellar zone and minimizes brain traction. This approach is particularly effective for the removal of large craniopharyngiomas, meningiomas, and pituitary adenomas with extrasellar growth. However, it requires significant retraction of the frontal lobe, which may increase the risk of postoperative complications. It was used in 66 patients.

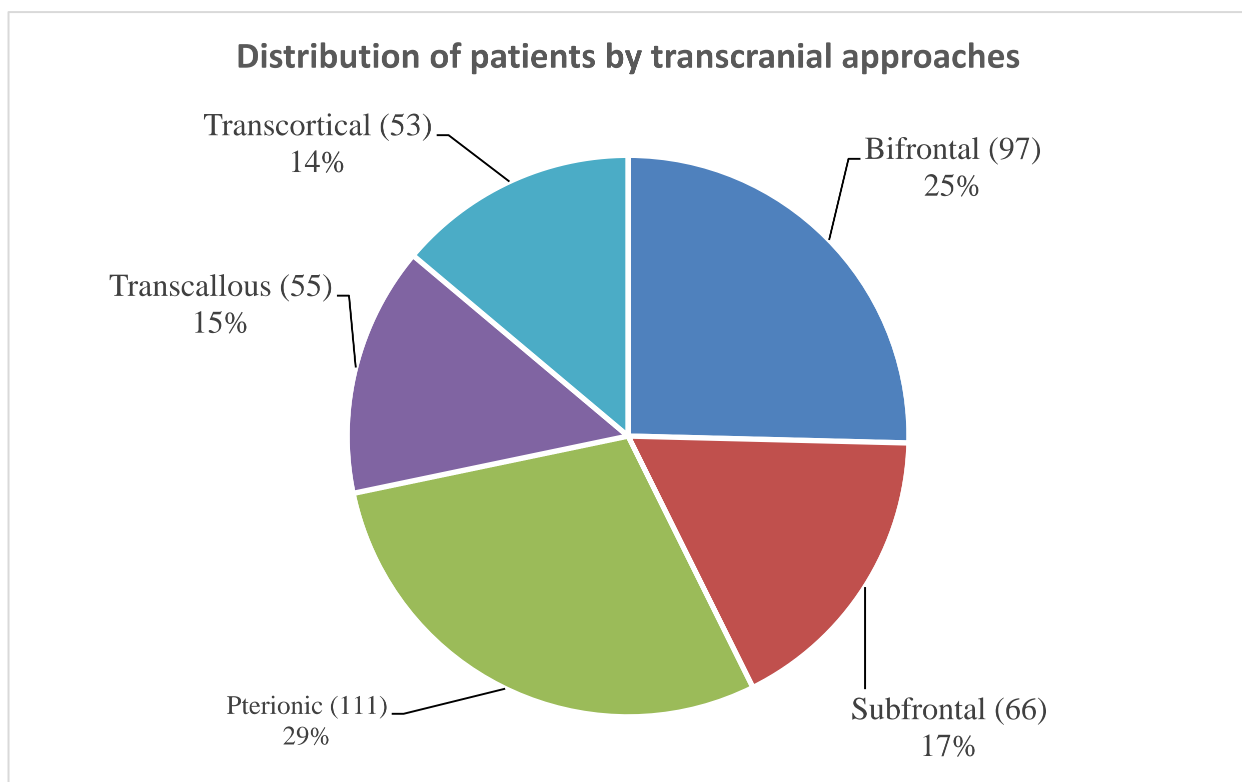

Figure 1. Distribution of patients by transcranial access

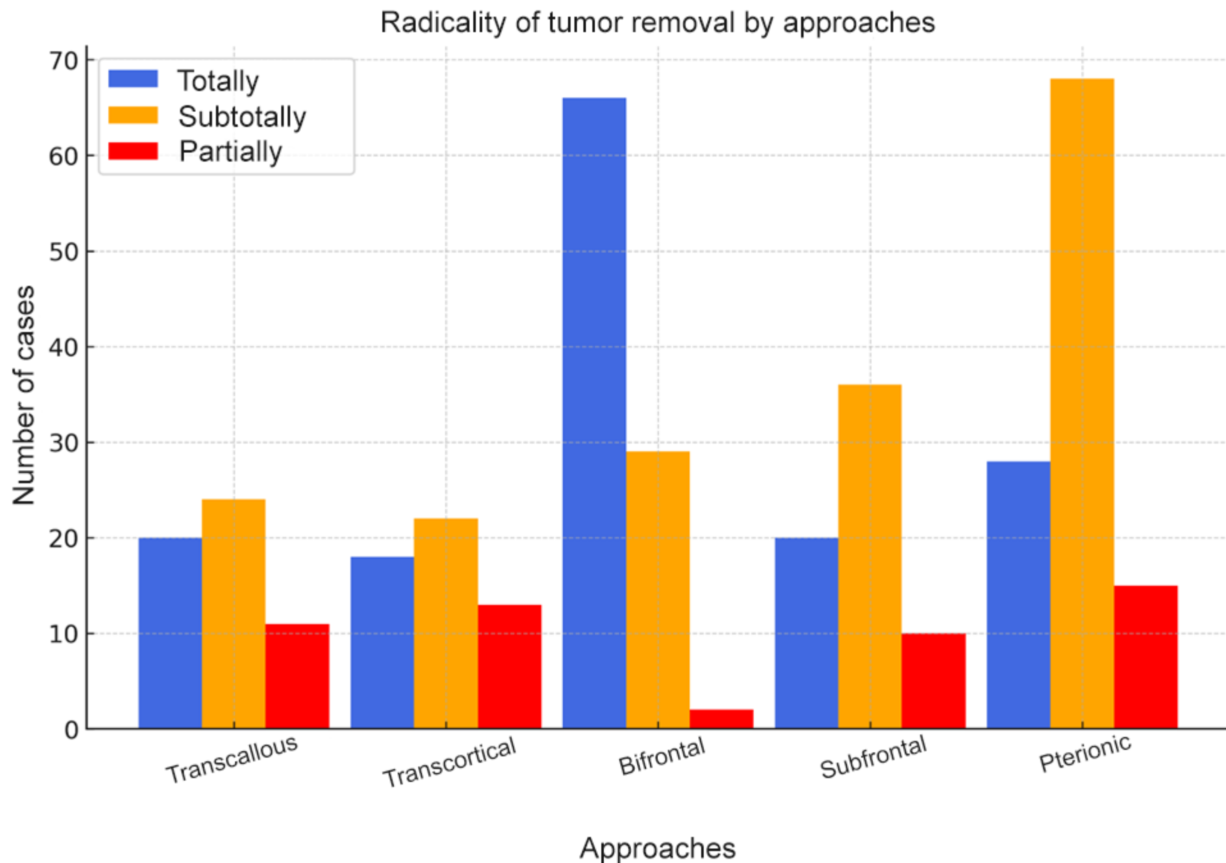

Figure 2. Radicality of tumor removal by access

Group IV. Pterional approach. In a series of craniopharyngioma cases, this approach was used exclusively in 111 of 382 (29.1%) operations. It is ideal in cases where the optic chiasm is fixed in the posterior position, but if necessary, pterional access also provides access to the lower anterior part of the third ventricle through the lamina terminalis. This approach was used in 111 patients.

Group V. Bifrontal access. In this approach, it is critical to ensure wide frontal access with access to the bottom of the anterior cranial fossa to minimize brain traction, performing cranialization of the frontal sinus if necessary. The key point is early opening of the subarachnoid space and slow drainage of cerebrospinal fluid, which promotes brain relaxation. The main risk of this method is postoperative seizures caused by traction of the frontal lobe combined with crossing of the pontine veins. The goal is to expose the optic nerves, optic chiasm, A2 segments, and anterior communicating artery by opening the chiasmal and interhemispheric cisterns. Access to large tumors is through the lamina terminalis, which reduces the risk of damage to the fornix. This access is considered the optimal transcranial method for removing retrochiasmal and suprasellar craniopharyngiomas, as it allows a median view of the interpeduncular cistern through the lamina terminalis. When removing a tumor from the retrochiasmatic space, it is necessary to protect the visual apparatus as much as possible, and to preserve the sense of smell, it is necessary to mobilize the olfactory tracts from the gyrus rectus. The advantage of the midline approach is the early visualization of important midline structures, which may be more difficult to identify with the pterional approach. It was used in 97 patients.

In order to further reduce the disadvantages of the existing bifrontal approach, a modified bifrontal approach was developed. The essence of this approach is to widen the interhemispheric fissure, which minimizes traction on the large hemispheres of the brain and preserves the integrity of the olfactory nerves. This modified approach was used in 28 of 97 patients.

3. Results and Discussion

We conducted a study of the radicality of removing tumors in the sella turcica region complicated by hydrocephalus, depending on the surgical approach used. Figure 1 shows that pterional and bifrontal approaches were mainly used to remove such tumors. In combination with the use of these approaches, total removal was achieved in 152 of the 382 patients who underwent surgery, which amounted to 40%. It should be noted that the more radical the tumor removal, the greater the risk of developing secondary disorders. This is because the tumor capsule is closely connected to the structures of the hypothalamus and is located in close proximity to the main artery, and in the postoperative period, diencephalic disorders are often observed in the form of an increase in body temperature, chills, general weakness,

and drowsiness. There is also a clinical picture of ADH (antidiuretic hormone) deficiency due to damage to the pituitary stalk, which is accompanied by polyuria, polydipsia, and decreased urine density.

Subtotal resection was performed in 179 (47%) patients. In some cases, due to the immediate proximity and close location to the main artery, removal of the lower part of the tumor capsule was impossible or excessively risky.

In 51 (13%) patients, due to the density of the tumor, its adhesion to surrounding structures, profuse bleeding, and hemodynamic instability during surgery, tumor removal was limited to partial removal.

Complications associated with damage to the diencephalic structures required intensive care, against which background an improvement in condition was noted on the 5th-7th day. In cases of ADH (antidiuretic hormone) deficiency, replacement therapy with desmopressin was administered at a dose of 1-2 drops per day, which patients received for a long time after discharge. In cases of visual impairment, patients received additional treatment from a neuro-ophthalmologist for an equally long period of time.

4. Conclusions

As a rule, most tumors of the sellar region are benign, slow-growing neoplasms. Early detection of these tumors is an important prognostic factor in surgical treatment, allowing for the most radical removal of the tumor, preservation of vital functions, and minimization of postoperative complications. This is due to the choice of the most optimal surgical approach for the operation. Figure 2 shows that when removing tumors of the suprasellar region of the brain, the use of a bifrontal approach allows for more complete and subtotal resection of the tumor compared to other approaches. This, in turn, led to the development of a modified bifrontal approach aimed at eliminating the shortcomings of the existing bifrontal approach and preventing possible complications associated with this method.

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