

NAVIGATING CHALLENGES IN THE RESECTION OF SELLA TURCICA TUMORS: A REVIEW OF SURGICAL TECHNIQUES

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Abstract: **INTRODUCTION:** The sella turcica, a critical anatomical depression in the sphenoid bone, houses the pituitary gland and is closely associated with vital neurovascular structures, posing significant challenges for surgical interventions on tumors in this region. Diagnostic imaging, particularly MRI, is pivotal for delineating tumors and planning surgery, while the necessity of biopsy prior to curative intervention depends on the suspected tumor type, with pituitary adenomas often not requiring biopsy but non-pituitary tumors generally needing histological confirmation to guide treatment strategies. **OBJETIVE:** Analyze and describe the main aspects of Surgical Techniques in the Resection of Sella Turcica Tumors in the last years. **METHODS:** This narrative review used as descriptors “Neurosurgical Procedures,” “Diagnostic Imaging Techniques,” “Endoscopic Surgical Techniques,” “Pituitary Neoplasms,” and “Neuroendocrinology” included studies in the MEDLINE – PubMed (National Library of Medicine, National Institutes of Health), COCHRANE, EMBASE and Google Scholar databases. **RESULTS AND DISCUSSION:** The surgical management of tumors in the sella turcica has evolved significantly, predominantly favoring minimally invasive transsphenoidal approaches due to their efficacy and safety. These methods, especially when utilizing endoscopic techniques, offer superior visualization and reduced morbidity compared to traditional approaches like the transcranial route. Technological advancements, such as intraoperative imaging and robotic surgery, although limited by cost and training requirements, further enhance surgical precision and outcomes. The importance of an interdisciplinary approach involving neurosurgeons, endocrinologists, and radiologists is emphasized to optimize patient outcomes. Future directions point towards personalized surgical interventions

and the integration of emerging technologies like artificial intelligence to predict outcomes and improve surgical planning, aiming for maximal tumor resection with minimal complications. **CONCLUSION:** The review of surgical approaches for tumors in the sella turcica underscores the advantages of minimally invasive endoscopic transsphenoidal methods, which optimize recovery and reduce morbidity. Future advancements in technology and interdisciplinary collaboration are anticipated to further refine these surgical techniques, enhancing precision and patient-specific outcomes.

Keywords: Sella Turcica; Pituitary Adenoma; Surgery Approaches; Neuroendocrinology.

INTRODUCTION

The sella turcica, a saddle-shaped depression in the sphenoid bone at the base of the human skull, serves as the seat for the pituitary gland. Anatomically, it is bounded anteriorly by the tuberculum sellae and posteriorly by the dorsum sellae, while being intimately related to critical neurovascular structures, including the optic chiasm superiorly and the cavernous sinuses laterally¹. This central and crucial location not only underscores its physiological significance but also complicates surgical interventions due to the density and importance of the adjacent anatomical features¹. The sella turcica's proximity to the sphenoidal sinus provides a pathway for certain surgical approaches but also poses potential risks for cerebrospinal fluid leakage and infections².

Tumors arising in the sella turcica can be primarily of pituitary origin or may originate from surrounding structures, thus being categorized as pituitary or non-pituitary tumors. Pituitary adenomas are the most common type, constituting approximately 10-15% of all intracranial neoplasms³. Non-

pituitary tumors in this region include craniopharyngiomas, meningiomas, and metastatic lesions, which, though less frequent, present significant challenges due to their nature and the potential for more extensive involvement of surrounding structures⁴. Each tumor type exhibits distinct biological behaviors, growth patterns, and implications for surgical planning and prognosis⁴.

Clinically, tumors in the sella turcica manifest a spectrum of signs and symptoms, influenced by their size, growth rate, and the extent of local structure involvement. Ophthalmological symptoms are prevalent due to the proximity to the optic chiasm, with patients often presenting with bitemporal hemianopsia as seen in campimetry tests⁵. Neurological manifestations can include headaches, seizures, and cognitive dysfunctions, which are primarily related to increased intracranial pressure or direct tumor impact on cerebral structures⁶. Additionally, pituitary tumors may cause hormonal imbalances leading to conditions such as acromegaly, Cushing's disease, or hypopituitarism, depending on the type and activity of the adenoma⁷.

Diagnostic imaging plays a pivotal role in the evaluation and management of sella turcica tumors. Computed tomography (CT) scans and magnetic resonance imaging (MRI) are indispensable tools in the diagnosis and preoperative planning for these tumors⁸. MRI, with its superior soft-tissue contrast, is particularly valuable in delineating the tumor's extent, its relationship with adjacent neurovascular structures, and in evaluating potential cavernous sinus invasion⁸. CT scans, on the other hand, provide excellent detail of the bony anatomy, which is crucial for planning the surgical approach, especially in procedures that involve bone removal, such as the transsphenoidal approach⁹.

While imaging provides critical structural information, the definitive diagnosis of the nature of sella turcica tumors often requires histopathological examination. The decision to biopsy a tumor prior to curative surgery depends on the tumor type suspected on imaging¹⁰. For instance, pituitary adenomas, which are often diagnosed based on clinical and hormonal studies complemented by MRI, typically do not require a biopsy before surgery¹⁰. Conversely, non-pituitary tumors, which may include a wider differential diagnosis involving malignancies, generally necessitate a biopsy to determine the precise histological type and to guide treatment strategy¹¹. Thus, while not always necessary, biopsy can be crucial when imaging and clinical findings do not conclusively establish the tumor type or when a malignancy is suspected^{10,11}.

OBJETIVES

Analyze and describe the main aspects of Surgical Techniques in the Resection of Sella Turcica Tumors in the last years.

SECUNDARY OBJETIVES

1. Evaluate the safety and efficacy of different surgical approaches for the resection of tumors in the sella turcica, such as transsphenoidal, transcranial, and endoscopic methods.
2. Compare the short-term and long-term outcomes of various surgical techniques, focusing on complication rates, success rates, and recurrence rates.
3. Review the impact of recent technological advancements in surgery, including enhanced imaging techniques, robotic surgery, and intraoperative navigation systems, on the outcomes of sella turcica tumor resections.
4. Identify and discuss the indications for different surgical routes based on tumor

size, location, type, and patient-specific factors.

5. Assess the impact of surgical interventions on the patient's postoperative quality of life and neurological function.

METHODS

This is a narrative review, in which the main aspects of Surgical Techniques in the Resection of Sella Turcica Tumors in recent years were analyzed. The beginning of the study was carried out with theoretical training using the following databases: PubMed, sciELO and Medline, using as descriptors: "Neurosurgical Procedures" AND "Diagnostic Imaging Techniques" Endoscopic Surgical Techniques" AND "Pituitary Neoplasms" AND "Surgery Approaches" AND "Neuroendocrinology" in the last 10 years. As it is a narrative review, this study does not have any risks.

Databases: This review included studies in the MEDLINE – PubMed (National Library of Medicine, National Institutes of Health), COCHRANE, EMBASE and Google Scholar databases.

The inclusion criteria applied in the analytical review were human intervention studies, experimental studies, cohort studies, case-control studies, cross-sectional studies and literature reviews, editorials, case reports, and poster presentations. Also, only studies writing in English and Portuguese were included.

RESULTS AND DISCUSSION

The comparative review of different surgical approaches for the resection of tumors in the sella turcica reveals distinct advantages and challenges associated with each method¹². The transsphenoidal approach, particularly its endoscopic variant, has been consistently highlighted for its less invasive nature and its ability to allow for direct access to the sellar region without disturbing the brain or other cranial structures¹². This method

has demonstrated lower morbidity rates and improved recovery times compared to more invasive approaches like the transcranial route^{12,13}. Furthermore, endoscopic techniques enhance the surgeon's ability to visualize the surgical field, which is crucial for ensuring complete tumor resection and minimizing post-operative complications, including those that affect hormonal function crucial for patient quality of life¹⁴.

Technological advancements have been pivotal in refining surgical outcomes for sella turcica tumors. Intraoperative imaging technologies, such as MRI and CT scans, have facilitated a higher precision in tumor delineation, enabling surgeons to achieve maximal resection while sparing normal pituitary tissue¹⁵. This precision is crucial for avoiding recurrence and reducing the need for subsequent treatments¹⁵. Robotic surgery has also begun to find its place in pituitary tumor resections, offering enhanced dexterity and stability during surgical maneuvers. Despite its benefits, the adoption of robotic technology in pituitary surgery faces hurdles such as cost implications and the requirement for extensive training, limiting its widespread use¹⁶.

Studies focusing on patient-centric outcomes have consistently shown that minimally invasive surgical techniques, particularly those that utilize endoscopic approaches, significantly improve postoperative recovery times and overall quality of life¹⁷. These techniques, by minimizing brain tissue disruption, tend to preserve pituitary function better, which is crucial given the pituitary's role in regulating multiple endocrine functions throughout the body¹⁸. Additionally, less invasive methods have been associated with reduced incidence of diabetes insipidus, a common complication following pituitary surgery¹⁹.

Anatomical variations in the sellar region significantly influence the choice of surgical approach²⁰. The surgeon must consider factors such as the size and extension of the tumor, the proximity to critical vascular and neural structures, and individual variations in skull base anatomy. These factors are critical for planning the surgical route, as they affect both the feasibility of complete tumor resection and the risk of complications²¹.

The interdisciplinary nature of modern surgical management of sella turcica tumors is another crucial aspect²³. The collaboration between neurosurgeons, endocrinologists, radiologists, and sometimes ophthalmologists, ensures that each aspect of the tumor's impact, from hormonal disturbances to potential visual field impairments, is comprehensively managed²⁴. Future directions in this field are likely to involve more personalized surgical interventions, driven by advances in preoperative imaging and surgical simulation²⁵.

Additionally, the field may see increased use of biomaterials designed to optimize healing and structural integrity post-surgery, thereby minimizing common postoperative challenges such as cerebrospinal fluid leaks²⁷. Emerging technologies like artificial intelligence are also expected to play a growing role in preoperative planning, providing predictive insights based on vast datasets of patient outcomes, which could further tailor surgical strategies to individual patient anatomies and tumor characteristics^{28,29}.

CONCLUSION

In conclusion, the review of surgical approaches for resecting tumors in the sella turcica highlights the distinct benefits and challenges of each method, with a strong preference for minimally invasive techniques, particularly the endoscopic transsphenoidal approach. This method, celebrated for its direct access and minimal disruption of surrounding tissues, has proven effective in reducing morbidity and enhancing postoperative recovery. Technological innovations like intraoperative imaging and robotic surgery continue to refine the precision of tumor resections, though their adoption is curtailed by high costs and training demands.

The emphasis on patient-centric outcomes has validated the advantages of minimally invasive methods in preserving crucial pituitary function and improving quality of life. Anatomical considerations remain central in surgical planning, necessitating a tailored approach to each case based on unique anatomical landscapes. The integrated efforts of interdisciplinary teams are vital in managing the broad impacts of these tumors, from hormonal to visual functions.

Looking forward, the field is set to advance with more personalized surgical interventions and the integration of cutting-edge technologies like artificial intelligence, promising even greater precision and tailored patient care. These developments are expected to further enhance surgical outcomes, reduce complications, and potentially revolutionize the treatment landscape for patients with sella turcica tumors.

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