Anterior Skull Base Tumors: comparative Analysis of Endoscopic and Open Approaches, Tumors Classification, Prevalence and Associated Surgical Complications. A Systematic Review

Ubaid Ullah (ubaidullahkmc@gmail.com)
Khyber Medical College

Sajjad Ullah Dawar
Khyber Teaching Hospital

Systematic Review

Keywords: Anterior skull base tumors, open approach to anterior skull base, endoscopic approach, pituitary injury, ICA injury, Bleeding, Cavernous sinus, Meningiomas, pituitary adenomas, Abducent nerve palsy, Neurological injuries, CSF leaks, Skull base metastasis, Glomus Tumor, Cavernous sinus tumors, Chordomas, chondrosarcomas, sellar and para sellar tumors, craniopharyngiomas, Craniotomy

Posted Date: October 12th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-3424963/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License
Abstract

Objective: To conduct a review on different types of anterior skull base tumors, their prevalence, approaches toward them, and pre, intra, and postoperative complications.

Introduction

Anterior skull base tumors present unique challenges due to their proximity to vital structures. Surgical management has evolved with the advent of endoscopic and open techniques. Endoscopic procedures, involving small incisions and specialized tools, reduce morbidity and hasten recovery. Open techniques offer direct tumor access, enabling complete removal. Meningiomas are the most common tumor type, with esthesioneuroblastoma and other rare variants also occurring. Incidence varies by histology and demographics. Surgery carries inherent risks, such as structural damage, visual impairment, fluid leaks, bleeding, infection, and brain injury, influenced by tumor characteristics and surgical approach. Advances in techniques and monitoring have improved patient outcomes. Understanding these approaches, tumor types, prevalence, and complications is vital for effective management of anterior skull base tumors.

Materials and Methods

To conduct a review on different types of anterior skull base tumors, their prevalence, approaches toward them, and pre, intra, and postoperative complications, I searched almost all articles related to topic or its key words such as endoscopic approach, anterior skull base tumors, surgical complications on PubMed MEDLINE, JSTOR, Science Direct, cochrane and Google scholar database. After going through 2000 articles I selected all those articles from 1981 through 2022 which contain review articles, case studies and retrospective studies related to topic. The PRISMA (preferred reporting items for systematic review and metaanalysis) flow sheet for the search is given in FIG 1. Detail of the information extracted from each selected article, mentioned in references. Data was categorized on basis of, surgical approach, tumor type, prevalence rates, and complications. A cumulative total of 2000 prospective studies were identified after compiling search results. Following the elimination of duplicate entries, a total of 1180 potential investigations were discovered. The remaining articles were screened to determine their relevancy based on their title and abstract. After conducting a manual search of titles and abstracts, a total of 58 references were identified and included in the study.

Conclusion

The present study provides an overview of the surgical techniques used in resecting anterior skull base tumors, specifically focusing on endoscopic and open procedures. The article examines the frequency and classifications of tumors, including pituitary adenomas, meningiomas, esthesioneuroblastomas, chordomas, and craniopharyngiomas. The endoscopic method is associated with less morbidity and expedited recovery, but the open approach gives a broader field of view for managing bigger or more intricate malignancies. The management of surgical complications such as cerebrospinal fluid leaks, meningitis, vascular damage, and vision abnormalities is discussed. The study underscores the significance of interdisciplinary teamwork, thorough planning, and improved methodologies in enhancing results.

INTRODUCTION

Anterior skull base tumors include a wide range of neoplasms [1] that originate anatomically in the area between the cranial base and facial structures. The presence of these tumors might pose considerable difficulties owing to their anatomical positioning close to vital tissues such as the brain, eyes, and major blood arteries. With time, significant breakthroughs in surgical procedures have brought about a revolutionary transformation in the treatment of malignant tumors. There are two main techniques often used for the resection of tumors which are essentially endoscopic [2] and open procedures [3]. Each of these approaches has unique benefits and concerns.

Endoscopic procedures include the use of minimally invasive methodologies, which entail employing tiny incisions and specialized devices to access and extract the tumor. These methodologies frequently use endoscopes, providing exceptional viewing and magnification capabilities inside the surgical domain. Compared to conventional open techniques, they provide advantages such as decreased morbidity, shorter hospitalization durations, and expedited recovery periods. The use of endoscopic procedures has become more prevalent in the treatment of cancers situated inside the nasal cavity, paranasal sinuses, and suprasellar area [2].

Conversely, open procedures include the use of larger incisions and may need the extraction of bone in order to get access to the tumor. These devices provide a means of directly accessing the tumor, facilitating the surgeon in achieving a thorough removal of the tumor while ensuring sufficient visibility and reducing the potential for harm to adjacent vital tissues. Open techniques are often used when larger tumors affect the anterior cranial fossa, cribiform plate, and ethmoid sinuses [3].

Anterior skull base tumors include a diverse range of histological forms, such as meningiomas [4], esthesioneuroblastomas, chordomas, chondrosarcomas, and squamous cell carcinomas. Meningiomas are the predominant malignancies in this specific geographical area,
constituting nearly one-third of all reported occurrences [4]. Meningiomas often originate from the dura mater and may exhibit either benign or malignant characteristics. Esthesioneuroblastomas are an infrequent kind of neoplasms that originate from the olfactory epithelium. These tumors represent a lesser but noteworthy proportion of cancers located in the anterior skull base.

The incidence of these cancers exhibits variability based on the particular histological subtype and geographical region. As an example, it is seen that meningiomas have a higher prevalence among females. Still, esthesioneuroblastomas display a bimodal age distribution characterized by two distinct peaks occurring throughout infancy and middle life. The prevalence of anterior skull base tumors is generally modest, with estimated rates ranging from 1 to 5 instances per 100,000 individuals [1].

The surgical removal of malignancies located in the anterior skull base are associated with inherent risks and potential complications. Possible consequences of the circumstances mentioned above include harm to vital anatomical structures such as the optic nerves, carotid arteries, and frontal lobes of the cerebral cortex, resulting in visual impairment, cerebrospinal fluid leakage, hemorrhaging, infection, and cerebral impairment [4]. The degree of difficulties is contingent upon several aspects, such as the dimensions of the tumor, its placement, level of invasiveness, and the specific surgical technique used. The use of advanced surgical procedures, preoperative imaging, and intraoperative monitoring has played a crucial role in reducing the occurrence of problems and enhancing patient outcomes.

**Materials and Methods**

**Search Strategy**

I searched almost all articles related to topic or its key words such as endoscopic approach, anterior skull base tumors, surgical complications on PubMed MEDLINE, JSTOR, Science Direct, Cochrane and Google scholar database.

**Study Selection**

After going through 2000 articles I selected all those articles from 1981 through 2022 which contain review articles, case studies and retrospective studies related to topic. A cumulative total of 2000 prospective studies were identified after compiling search results. Following the elimination of duplicate entries, a total of 1180 potential investigations were discovered. The remaining articles were screened to determine their relevancy based on their title and abstract. After conducting a manual search of titles and abstracts, a total of 58 references were identified and included in the study The PRISMA (preferred reporting items for systematic review and metanalysis) flow sheet for the search is given in Fig. 1.

**Data Synthesis**

Data was categorized on basis of, surgical approach, tumor type, prevalence rates, and complications.

**Ethical Considerations**

No ethical considerations encountered

**Discussion**

Endoscopic Approach

Preoperative CT angiography is a crucial step in modern surgical procedures, particularly in the realm of neurosurgery and endoscopic endonasal approaches (EEAs). This imaging technique enables surgeons to perform frameless stereotactic image-guided surgeries with precision. In some cases, it is complemented by a contrast MR image to provide a comprehensive view of the patient's anatomy. Before surgery commences, patients typically undergo orotracheal intubation for safe anesthesia management. Once positioned, a 3-pin head holder is used to stabilize the patient's head, with the neck slightly extended and rotated to the right for optimal access. To alleviate nasal congestion, 0.05% oxymetazoline with 0.5 × 3–in cottonoids is applied topically. When autologous fat-free grafts are required for reconstruction, a povidone solution is administered to specific regions, such as the perinasal and periumbilical areas. The cornerstone of EEAs is the establishment of a bilateral nasal corridor (binares), a fundamental step in these procedures. This involves resecting or lateralizing the right middle turbinate and lateralizing the left middle turbinate. A posterior septectomy is a crucial component of this strategy, allowing unobstructed bimanual instrument manipulation and preventing contamination of the endoscope, thereby improving visibility during surgery. While the binares approach is typically employed, there are exceptions [5],[6],[7]. Binostril approaches may be considered in cases where noncomplex disorders affect only one nasal cavity or the anterior skull base extradurally. Examples include unilateral cerebrospinal fluid (CSF) leakage repair, orbit and optic nerve decompression, and select pediatric cases with narrow nasal passages, necessitating a sublabial incision for access. During surgery, a rod lens endoscope is used at a 0° angle, with continuous irrigation to maintain visual clarity. Inferior turbinate laterality is enhanced by performing a
right middle turbinectomy when necessary. Hemostasis is achieved using suction electrocautery, primarily at the posterior connection of the middle turbinate. A nasoseptal flap, based on the posterior septal arteries, is harvested to reconstruct skull base defects. It is essential to elevate the flap before performing the posterior septectomy to preserve its blood supply. The flap can be stored in the nasopharynx or ipsilateral maxillary sinus during dissection, facilitating visibility and protecting its integrity. The nasal corridor is further expanded with a posterior nasal septectomy, bilateral sphenoidotomies, and posterior ethmoidectomies. Subsequently, a 3- or 4-mm hybrid cutting/diamond bur is used to carefully drill the floor of the sphenoid sinus to align it with the clival recess, completing the surgical process. The technique may differ based on the specific disease or module used. The Median sagittal plane approaches are following.

<table>
<thead>
<tr>
<th>Module</th>
<th>Corridor</th>
<th>Anatomical Boundary</th>
<th>Cistern</th>
<th>Neurovascular Structures</th>
<th>Key Anatomical Landmark</th>
<th>Common Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transellar</td>
<td>sphenoid &amp; posterior ethmoid</td>
<td>Superior intercavernous sinus to inferior intercavernous sinus, cavernous to cavernous</td>
<td>Subdiaphragmatic &amp; suprasellar</td>
<td>carotid siphon; medial cavernous sinus; CNs III, IV, &amp; VI; optic chiasm</td>
<td>Tuberculum sellae, sellar floor; “4 blues” SIS to IIS &amp; cavernous sinuses</td>
<td>RCC, pituitary adenoma</td>
</tr>
<tr>
<td>Transplanum</td>
<td>sphenoid &amp; posterior ethmoid</td>
<td>posterior ethmoidal artery, sella posterior, optic canals, paraclinoid ICA laterally</td>
<td>Interhemispheric fissure</td>
<td>ant circle of Willis, chiasm, optic nerves, stalk, gyrus rectus, orbitofrontal gyrus</td>
<td>medial optocarotid recess, optic canals</td>
<td>meningioma, pituitary adenoma, cranioopharyngioma</td>
</tr>
<tr>
<td>Transcribiform</td>
<td>complete ethmoid, &amp; frontal sinus “Draf III”</td>
<td>back, wall of frontal sinus to planum, lamina papyracea to lamina papyracia</td>
<td>Interhemispheric fissure</td>
<td>A2 &amp; orbitofrontal, inferior sagittal sinus, gyrus rectus, orbitofrontal gyrus</td>
<td>anterieor &amp; posterior ethmoidal arteries, falx, periorbita</td>
<td>meningioma, esthesioneuroblastoma, olfactory schwannoma</td>
</tr>
<tr>
<td>Upper 1/3 of clivus</td>
<td>sphenoid &amp; nasopharynx, &amp; pituitary transposition</td>
<td>dorsum sella, pst clinoid, Dorello canal</td>
<td>ant 3rd ventricle, interpeduncular &amp; preoptine cistern, Liliequist membrane</td>
<td>CN III bilat, pituitary stalk, mammillary bodies, BA, P1 &amp; P2, PCoA, midbrain, pons</td>
<td>parasellar ICA, dorsum sellae, PC, pituitary transposition, &amp; cavernous sinus</td>
<td>meningioma, chordoma, cranioopharyngioma, pituitary adenoma</td>
</tr>
<tr>
<td>Middle 1/3 of clivus</td>
<td>sphenoid &amp; nasopharynx</td>
<td>Dorello canal (sellar floor) to level of foramen lacerum</td>
<td>Preoptine</td>
<td>BA, pst circle of Willis, CN VI, pons</td>
<td>margin, origin of abducens nerve, Dorello canal</td>
<td>meningioma, schwannoma, chordoma, chondrosarcoma</td>
</tr>
<tr>
<td>Lower 1/3 of clivus</td>
<td>sphenoid &amp; nasopharynx</td>
<td>foramen lacerum level through basion</td>
<td>preoptine, cervicomedullary</td>
<td>CN VI bilat, CN XII bilat, VAs, medulla</td>
<td>Verteobasilar junction margin, origin of abducens nerve</td>
<td>meningioma, chordoma, chondrosarcoma</td>
</tr>
<tr>
<td>Transodontoid</td>
<td>nasopharynx</td>
<td>basion to arch of C-1</td>
<td>cervicomedullary</td>
<td>VAs, CN XII bilat, medulla, spinal cord</td>
<td>ETs, odontoid ligaments, condyles</td>
<td>meningioma, chondrosarcomachordoma</td>
</tr>
</tbody>
</table>

ant = anterior; bilat = bilaterally; ET = eustachian tube; IHF = interhemispheric fissure; IIS = inferior intercavernous sinus; PC = posterior clinoid; PCoA = posterior communicating artery; pst = posterior; RCC = Rathke cleft cyst; SIS = superior intercavernous sinus; VBJ = verteobasilar junction

**OPEN APPROACH**

The following table gives an overview of the standard open methods used to remove front skull base tumors.
<table>
<thead>
<tr>
<th>Open Surgical Approaches</th>
<th>Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Craniotomy[8]</td>
<td>Surgical incision on the scalp - Creation of a bone flap inside the skull - Direct access to the tumor.</td>
</tr>
<tr>
<td>2. Transfacial Approach</td>
<td>Surgical incisions in the facial or neck region - Entry into the anterior skull base.</td>
</tr>
<tr>
<td>a) Transfrontal Approach[9]</td>
<td>Incision in the forehead - Access through frontal sinus or supraorbital area</td>
</tr>
<tr>
<td>b) Transmaxillary Approach[10]</td>
<td>Surgical incision in the maxilla (upper jaw bone) - Access through nasal cavity or maxillary sinus.</td>
</tr>
<tr>
<td>3. Trans Cranial Approach</td>
<td>Access to tumor through an incision in the skull - Removal of a section of cranial bone.</td>
</tr>
</tbody>
</table>

Classification of tumors and epidemiology
Tumor Type | Description | Epidemiology and Complications
--- | --- | ---
**Skull Base Tumors** | Benign tumors (e.g., meningiomas, sellar/parasellar tumors, vestibular and trigeminal schwannomas) [16]. Malignant tumors (e.g., chordomas, chondrosarcomas, metastases) | Meningiomas: 2 cases per 100,000 individuals annually. Pituitary tumors and vestibular schwannomas: 1 per 100,000 individuals [16], Skull base metastases: 18 per 100,000 individuals annually [17].

1. **Meningiomas** | Arise from the meninges, Predominant primary tumors at the base of the skull. | 5-year recurrence rates: 5% for grade I, 40% for grade II, 50–80% for grade III.

Anterior and Middle skull base meningiomas | Located in the anterior and central regions of the skull base including olfactory groove, planum sphenoidale, and tuberculum sellae meningiomas, Various surgical approaches employed [18]. | Anosmia (occurring in 10–20% of cases), cerebrospinal fluid (CSF) leakage (10% incidence), as well as visual abnormalities and bleeding (with a prevalence of 5–10%) [19].

2. **Pituitary Adenomas** | Originates from the pituitary gland, Classified as functional or nonfunctional adenomas [20]. | Approximately 97% of microadenomas and 70% of macroadenomas have secretory activity, as shown in a study [20], Surgical excision through transsphenoidal approach, Possible complications: damage to internal carotid artery, optic nerve, CSF leakage.

3. **Sellar and Parasellar Tumors** | Tumors inside or close to the sella turcica region of the skull. | Transsphenoidal surgery is the preferred method.

4. **Craniopharyngiomas** | Benign tumors outside brain tissue but inside the arachnoid membrane, Two histological subtypes: adamantinomatous (which accounts for around 95% of pediatric cases) and papillary squamous epithelium [21]. | The prevalence of their occurrence is around 0.1 cases per 100,000 individuals annually. More than 80% of these tumors are in the suprasellar region [21].

5. **Cavernous sinus Tumors** | Primary cavernous sinus meningiomas are uncommon, Surgical options depend on tumor location. | Account for less than 3% of all meningiomas, Current approaches involve excision for tumors outside the cavernous region or biopsy for tumors inside [22–23].

6. **Glomus Tumors (paraganglioma)** | Rare tumors, Gradual and localized invasive growth pattern, Various surgical approaches. | Have a low prevalence, occurring in around 1 to 3 instances per one million individuals, and are notably more common in females, with a female-to-male ratio of 6:1 [24]. Surgical excision after embolization is preferred, Common morbidities: facial paralysis, auditory impairment, cranial nerve palsies [25].

7. **Chordomas and Chondrosarcomas** | Rare, benign tumors from notochordal cell lineage, Limited responsiveness to radiation and chemotherapy. | The prevalence of this condition is 0.08 cases per 100,000 individuals annually, with a higher occurrence seen among men of Caucasian ethnicity [26].

8. **Esthesioneuroblastoma** | Uncommon neoplasm originating from olfactory epithelium, with the potential to infiltrate the cranial base, paranasal sinuses, and orbital structures. | Esthesioneuroblastomas comprise around 2–3% of the total number of intranasal neoplasms, Surgical excision is the primary treatment, Complete removal improves overall outcome, Common complications: CSF leakage, infection. [27–29].

9. **Craniofacial Malignancies** | Majority attributed to sinonasal malignancies, Often diagnosed late, Multidisciplinary approach. | Approximately 60–70% of sinonasal malignancies originate from the maxillary sinus, while 10–15% emerge from the ethmoid sinuses, and the remaining cases are derived from the frontal and sphenoid sinuses [30].

10. **Skull Base Metastasis** | Cranial base metastasis is observed in approximately 4% of cancer-diagnosed individuals [31]. The primary tumors most frequently associated with this condition include breast, lung, renal, and prostate cancers [17], [32]. | **Complications**

The complication rate associated with skull base surgery exhibits variability due to the diverse range of disorders being treated and the different techniques required to address lesions in the skull base. The existing body of researches on surgical removal of malignant skull base tumors often presents findings on complication and fatality rates, which typically fall within the range of 30–50% and 0–7%, respectively [33–34].

In recent research conducted by many institutions worldwide, the primary objective was to determine the factors that might predict the occurrence of morbidity and mortality associated with craniofacial resection for various skull base lesions. The study population consisted of 1,193 patients, and the respective morbidity and death rates were found to be 36.3% and 4.7%. The study found that comorbid medical conditions were a noteworthy indicator of mortality. Comorbid medical conditions, previous radiation treatment, dural invasion, and brain invasion were significant predictors of postoperative complications. The precise rate of complications associated with ESBS is not extensively established, but it seems similar or potentially more favorable compared to conventional techniques [35].
In a recent study conducted by Kassam et al. [57], the authors provided a comprehensive analysis of 800 endoscopic endonasal skull base surgeries (ESBS) to address various pathologies affecting the skull base. Excluding cerebrospinal fluid leaks, the aggregate incidence of problems associated with endoscopic skull base surgery (ESBS) was 9.3%. The review reported a cumulative cerebrospinal fluid (CSF) leak rate of 15.9%. Nevertheless, as previously mentioned, the postoperative cerebrospinal fluid (CSF) leakage rate exhibited variability. However, the use of pedicled flaps resulted in a reduction of the CSF leak rate to below 5% [36].
<table>
<thead>
<tr>
<th>Complications</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bleeding and vascular injury</td>
<td>Intraoperative bleeding influenced by tumor characteristics, duration, systemic conditions, and vascularity. Classiﬁed as venous/arterial and low-ﬂow/high-ﬂow [37].</td>
</tr>
<tr>
<td>Low Flow Venous Bleeding</td>
<td>Low-ﬂow arterial bleeding is characterized by bleeding from tiny vessels, such as perforating vessels Occurs during sinonasal corridor dissection [37].</td>
</tr>
<tr>
<td>High Flow Venous Bleeding</td>
<td>Hemorrhage originating from the cavernous sinus [37].</td>
</tr>
<tr>
<td>Low flow arterial bleeding</td>
<td>Bleeding from tiny vessels, such as perforating vessels [37].</td>
</tr>
<tr>
<td>High Flow arterial bleeding</td>
<td>Involves medium to large vessels, including the sphenopalatine or internal maxillary arteries, as well as the internal carotid artery (ICA) [37].</td>
</tr>
<tr>
<td>2. ICA Injury</td>
<td>Anatomical factors that provide hazards for intraoperative damage to the internal carotid artery (ICA) include carotid dehiscence, attachment of the sphenoid septum to the ICA, and medialization of the ICA. Additional concerns include the need for revision surgery, exposure to radiation, use of bromocriptine, and acromegaly. [37]</td>
</tr>
<tr>
<td>3. CSF Leaks</td>
<td>The most often seen post-operative complication after endoscopic skull base surgery. A comprehensive analysis of 56 research revealed that among a total of 11,826 patients who had skull base surgery, 753 individuals experienced cerebrospinal fluid (CSF) leakage. The incidence of postoperative cerebrospinal fluid (CSF) leakage was 7.2% with a 95% conﬁdence interval ranging from 5.9–8.7%. The heterogeneity across the included studies was substantial, with an I2 value of 82.3%. The rate of postoperative cerebrospinal ﬂuid (CSF) leaking remained consistent throughout different publishing years, as shown by the ﬁndings of a sensitivity study [38]. The present study conducted a thorough quantitative evaluation of postoperative cerebrospinal ﬂuid (CSF) leakage. The ﬁndings indicated that factors such as obesity, perioperative irradiation, and high intraoperative CSF ﬂow rate were associated with an increased likelihood of CSF leakage. Conversely, implementing a pedicled vascularized ﬂap signiﬁcantly reduced the risk of postoperative CSF leakage.</td>
</tr>
<tr>
<td>4. Neurological Injury</td>
<td>Neural injuries in Endoscopic Skull Base Surgery (ESBS) vary from 0–33%, inﬂuenced by case complexity. A previous study reported an overall 1.8% neural injury rate, with 0.5% permanent cranial neuropathy, 0.8% temporary neuropathy, and 0.5% temporary hemiparesis. Permanent cases involved cranial nerves VI, IX, X, XII, while temporary cases included cranial nerves III, V3 motor, V1, and hemiparesis. Difficulty levels (IV and V) predicted neurological damage. Exclusive extranasal surgery had a 2.4% neural injury rate, comparable to other procedures. Delayed deﬁcits occurred in 1.9%, with 0.6% permanent. Collective enduring neurologic impairment was &lt; 1%. [55].</td>
</tr>
<tr>
<td>5. Abduent nerve palsy</td>
<td>Abducnt nerve palsy, or cranial nerve VI palsy, affects the abducens nerve, the sixth cranial nerve, leading to impaired lateral rectus muscle function and causing double vision (diplopia). This nerve is located ventrally in the cranial nerves, particularly vulnerable during transclival and paramedian surgeries. Tumor presence in the prepontine cistern can displace the nerve, increasing surgical risk. Understanding typical anatomy and anticipating abnormalities can help prevent cranial nerve VI damage. Anatomical reference points, such as the vertebrobasilar junction, the lacerum section of the internal carotid artery (ICA), and cranial nerve V2, aid in avoiding damage. However, these methods require precise dissection near the ICA and involve sophisticated techniques, as they pose risks to both the ICA and cranial nerve VI’s vasa nervorum [39].</td>
</tr>
<tr>
<td>6. Pituitary Gland Dysfunction</td>
<td>Diabetes insipidus (DI), syndrome of inappropriate antidiuretic hormone release (SIADH), and panhypopituitarism are potential outcomes of hypothalamic-pituitary axis (HPA) disruption due to both pathology and surgical intervention, such as the endoscopic endonasal approach (EEA) [40]. Macroadenomas are often linked to disruptions in the anterior pituitary hormone axis compared to microadenomas, attributed to portal artery compression in the infundibulum or increased intrasellar pressure [41–43]. Post-operative, HPA disturbances can result from direct or indirect manipulation [44], necessitating close clinical and laboratory monitoring to prevent complications. Transient DI occurs in 4.6–8.7% of cases following EEA [44–48]. Addressing HPA dysfunction begins with pre-operative assessment, adjusting cortisol levels during anesthesia induction, and considering patient characteristics associated with increased risk. During surgery, manipulating the posterior gland or infundibulum traction can heighten the risk of HPA dysregulation, particularly with pars intermedia tumors and cystic adenomas [49].</td>
</tr>
<tr>
<td>7. Infections</td>
<td>The presence of sinonasal microbiota and its potential connection to the cerebral cavity theoretically poses an infection risk after endoscopic endonasal surgery (EEA) [50]. However, in the absence of cerebrospinal ﬂuid (CSF) leaks, the likelihood of meningitis or other intracranial infections is low. Failure to repair a functional CSF leak has been linked to a meningitis rate of up to 21% [51], emphasizing the importance of thorough intraoperative CSF leak repair [52]. Given the minimal infection risk and potential adverse effects of antibiotics, such as allergies, infectious colitis, and drug-resistant microbes, caution is advised in prescribing antibiotics for EEA. Studies on antibiotics in EEA primarily involve retrospective research with varying antibiotic protocols. The incidence of bacterial meningitis after EEA ranges from 0–0.69%, and there is no clear correlation between antibiotic selection, regimen duration, and post-operative meningitis rates. A recent trial found no signiﬁcant improvement in sinonasal quality of life with postoperative prophylactic oral antibiotics [53].</td>
</tr>
<tr>
<td>7. Venous thromboembolism (VTE)</td>
<td>VTE is a rare occurrence in individuals undergoing endoscopic endonasal approach (EEA) procedures, but it may be more prevalent in older patients or those with coagulation issues and peripheral vascular disease. For such patients, using sequential compression devices and pharmacologic VTE prophylaxis is advisable, especially if they experience complications like cerebrospinal fluid (CSF) leakage or cranial nerve dysfunction, which can lead to prolonged immobilization and hospital stays [54].</td>
</tr>
</tbody>
</table>
Complications | Discussion
--- | ---
8. Cerebral infarction | Can result from various factors during EEA, including vasospasm, subarachnoid hemorrhage, vascular damage, or electrolyte imbalances. Some institutions employ strategies to reduce vasospasm, such as normal saline irrigation, vasodilating agents, and intravenous nimodipine postoperatively [55].
9. Pneumocephalus | The presence of air within the intracranial space, can occur immediately or later after EEA. It may be due to unidirectional valves or CSF drainage. Careful lumbar drain management and sinus precautions can minimize the risk and extent of pneumocephalus [56, 57].

Perioperative Considerations | Perioperative safety measures include nasal decongestants to reduce bleeding, image guidance for navigation, preparation of tissue graft sites, proper positioning of tubes, and optimizing surgeon ergonomics. Considerations like inserting arterial lines or urine catheters depend on the specific procedure. Manipulating the posterior pituitary gland can lead to diabetes insipidus or syndrome of inappropriate antidiuretic hormone secretion, necessitating vigilant fluid monitoring [58].

Conclusion
This review article provides a comprehensive overview of anterior skull base tumors and compares the two main surgical approaches used for their resection: endoscopic endonasal approach (EEA) and open approach. The article highlights the types of tumors commonly encountered in the anterior skull base and discusses their prevalence.

The EEA has gained popularity over the years due to its minimally invasive nature and direct access to the tumor through the nasal cavity. It offers several advantages, including reduced morbidity, shorter hospital stays, and faster recovery times. On the other hand, the open approach provides a wider exposure and is more suitable for larger tumors or cases with complex anatomy.

The review sheds light on various anterior skull base tumors, such as pituitary adenomas, meningiomas, esthesioneuroblastomas, chordomas, and craniopharyngiomas. It discusses their clinical presentation, diagnostic modalities, and specific challenges associated with their surgical resection. Additionally, the prevalence of these tumors is highlighted, emphasizing the importance of early detection and timely intervention.

However, despite the advancements in surgical techniques, complications can still occur during tumor resection. The article addresses common surgical complications associated with both EEA and open approaches, such as cerebrospinal fluid leaks, meningitis, vascular injury, and visual disturbances. It emphasizes the significance of meticulous surgical planning, intraoperative monitoring, and postoperative care to minimize these complications and optimize patient outcomes.

Overall, this systematic literature review article provides valuable insights into the management of anterior skull base tumors. It emphasizes the need for a multidisciplinary approach involving neurosurgeons, otolaryngologists, and other specialists to achieve successful tumor resection while ensuring the best possible patient outcomes. Further research and technological advancements are warranted to enhance surgical techniques, minimize complications, and improve long-term patient prognosis in the field of anterior skull base tumor management.

Declarations
Competing interests: The authors declare no competing interests

Ethics: The study was approved by the Khyber Medical College Peshawar Institutional Research and Ethical Review Board.

References


**Figures**
Figure 1: Study Selection Flow Diagram.

56 references were included in review

Figure 1
Study selection flow diagram