

Original Research

Evaluation of Outcomes and Complications of Sphenoid Wing Meningiomas in Tertiary Care Hospital of KPK

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ABSTRACT

Objective: The objective of this study is to evaluate the outcomes and complications associated with pterional craniotomy and extended pterional craniotomy for the resection of Sphenoid Wing Meningiomas.

Material and Methods: A prospective study was conducted on 34 patients at the Neurosurgery department, Prime Teaching Hospital, Pakistan, and Ali Institute of Neurosciences. We examined 34 recently diagnosed cases of sphenoid wing meningiomas, selected through a total enumerative sampling method. Diagnosis of these meningiomas was confirmed by comprehensive neurological assessment and imaging studies. Various surgical techniques, such as Pterional and Extended Pterional approaches, were employed in the procedures. Assessment of clinical outcomes and complications was conducted during follow-up evaluations. A total of 34 patients diagnosed with sphenoid wing meningiomas were covered as the study's target population. All patients met certain criteria to be included in the study.

Results: 25 (73.6%) of the total number of patients were females and 9 (26.4%) were males. The mean age at diagnosis was 47 ± 5 years. Presenting symptoms included headache, seizures, visual loss, motor deficit, and cognitive decline. Surgical techniques used in tumor resection were pterional craniotomy and extended pterional craniotomy. Post-operative evaluation after follow-up studies showed that the symptoms reversed, including a reduction in headache, vision restoration, seizure control, and motor and cognitive function improvement.

Conclusion: Pterional approach and extended Pterional approaches related to SWM removal are satisfactory rates of an acceptable and safe surgical treatment with satisfactory results concerning the total resection rate and related clinical improvement.

Keywords: Pterional Craniotomy, Extended Pterional Craniotomy, Sphenoid wing meningiomas (SWM).

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INTRODUCTION

Sphenoid wing meningiomas make up about 16–

20% of intracranial meningiomas and are among the three most common meningiomas.¹ They are challenging to surgical approach and to remove because of their location along the skull base with the involvement of bone as well as their location in the vicinity of significant arteries and nerves. This makes the Sphenoid wing meningiomas have a high rate of morbidity and mortality when compared to other types of meningiomas.²

SWMs symptoms involve headaches, blurring or loss of vision, protrusion of the eyeball, and weakness of one side of the body or a limb. Although microsurgical management of SWMs has been reported in many studies, the focus is on the statistical analyses including factors that influence the postoperative quality of life of these patients. Specifically, this study is focused on the surgically treated patients of SWMs following the clinical examination, exploring several clinical variables and using statistical methods.³

Performing surgical excision of sphenoid wing meningiomas with periorbital involvement is a complicated procedure due to the technical challenges. These challenges include careful removal of hyperostosis while making sure adequate margins are excised, reconstruction of the bony structure, as well as the dura mater, is necessary, and the preservation of critical cranial nerves such as the optic nerve, oculomotor nerve, and vessels including internal carotid artery.⁴ With these orbit-invading meningiomas, there can be several risks including loss of vision, restriction of extra-ocular movement of the eye, and cerebrospinal fluid leakage. The exposure of the cranial fixation plate used for bony work can lead to infection.⁵ Usually, Neurosurgeons face difficulty while operating on the periorbital invading sphenoid wing meningiomas. These tumors are anatomically very unusual due to their deep location at the base of the skull, and they are quite uncommon. Although theoretically, it is preferable to do a gross total resection of the tumor including the hyperostosis and periorbital invasion, aggressive surgery usually results in

unwanted consequences such as visual deterioration or protrusion of the eye on the tumor's side. The situation is further complicated by the presence of eloquent structures in the vicinity of the tumor which further increases the susceptibility to damage during surgery. To control and safely excise the periorbital invaded part of the tumor to handle the hyperostosis and bony protrusions and to do safe and precise reconstruction of the orbit, skilled surgical techniques by an experienced surgeon are required. Surgery is not always advised for sphenoidal meningiomas with periorbital invasion, and the treatment planning differs depending on the surgeon's expertise and personal preference⁶. The rate of complications for patients who underwent aggressive resection of spheno-orbital meningiomas ranged from 20% to 40%, according to the 2019 study. It is important to note, that periorbital invasion cases were not specifically included in the analysis for additional patient data analysis.⁷ Sphenoid wing meningiomas (SWM) comprise between 12%–20% of all cranial meningiomas. Eisenhardt and Cushing had initially distinguished SWM into two major types that are en-plaque tumors and globoid tumors. The Globoid tumor type is further subdivided into three groups: 1) lateral 2) middle; and 3) medial, according to the location of the tumors along the sphenoid wing at the skull base. The en-plaque type of SWM is differentiated from the rest by hyperostosis of the bone.⁸ Neurosurgeons must keep a delicate balance between the risks involved in the aggressive excision of the tumor and the preservation of the surrounding neurovascular structures, especially when operating on the meningiomas situated on the inner third of the sphenoidal wing. They must also consider the possibility of tumor advancement into the cavernous sinus.⁹ The main goal of microsurgery is to preserve the visual apparatus and to save the vision from further deterioration. Nevertheless, the main challenges faced by Neurosurgeons in safely removing the tumor include problems with

surgical anatomy, major neurovascular bundles, and the behavior of the tumor itself. Managing these tumors is very technical and at times made difficult by issues such as the extension of the tumor to the contralateral side, involvement of the cavernous sinus, encasement of blood vessels, calcification, and infiltration of the skull base.¹⁰

Among the meningiomas that are found above the tentorium cerebelli, 20% comprise the sphenoid ridge meningiomas and less than half of these meningiomas come from the sphenoid bone's inner ridge.¹¹ Within intracranial meningiomas, sphenoidal wing meningiomas (SWMNGs) are one of the top three most common tumors.¹² Like most meningiomas, SWMNGs are also present in the fourth decade of life. They are notably more common in females. Early signs and symptoms may include headaches, seizures, visual loss, and rarely weakness. Loss of consciousness is very unusual with SWM. The en-plaque type with hyperostosing bone is almost always found in women manifests as a unilateral protrusion of the eye and is mostly painless. A variety of techniques have been described in the literature for the treatment of SWMs, such as microsurgery, microsurgery plus radiotherapy, in addition to close monitoring with follow-up scans.¹³ The role of alternative treatments like radiotherapy has been seen to have a good outcome to prevent recurrence and as an adjuvant therapy for the histopathological proven malignant SWMs.¹⁴ Neurosurgeons often divide the globoid tumors into two main groups: a medial group and a middle/lateral group based on the lower risk of surgical complications with the latter group.¹⁵ The sphenoid wing is roughly defined as a boundary between the anterior and middle cranial fossa. Meningiomas are often the most prevalent tumors found on the sphenoid wing.¹⁶ The primary objective of surgical intervention is to achieve maximal tumor removal while minimizing the associated neurological complications. However, accomplishing gross total and safe resection continues to pose a major challenge for

neurosurgeons. Despite the modern-day techniques and recent advancements in skull base approaches and advanced neuroimaging, long-term postoperative outcomes remain suboptimal, especially for the Clinoidal type of SWM.¹⁷

Individuals with medial SWMs often exhibit minimal functional deficits upon presentation, making preservation and restoration of function, including returning to work and preoperative levels of activity, a key treatment objective. Given the elevated risks of mortality, permanent neurological deficits, and unfavorable outcomes associated with surgery, many neurosurgeons opt for subtotal or partial resection followed by adjuvant radiotherapy¹⁸. Primary cancers known as meningiomas are derived from the arachnoid meninges' cap cells. They are usually benign and are found outside the brain tissue. Based on research of 18,171 instances, meningiomas represent 19% of all cancers affecting the central nervous system. They are one of the main tumor forms impacting this system.¹⁹ Around 2.4% of all the patients that were investigated had the meningiomas discovered unexpectedly during postmortem; that is, meningiomas made up nearly 30% of the tumors found during these investigations which suggests that these benign lesions can sometimes act as a silent killer.²⁰

MATERIAL AND METHODS

Study Design & Setting

A prospective study was conducted on 34 patients at the Neurosurgery Department, Prime Teaching Hospital, Pakistan, and Ali Institute of Neurosciences (IGH) between April 2019 and May 2023. We examined 34 recently diagnosed cases of sphenoid wing meningiomas, selected through a total enumerative sampling method. Diagnosis of these meningiomas was confirmed by comprehensive neurological assessment and imaging studies. Various surgical techniques, such as Pterional and Extended Pterional approaches,

were employed in the procedures. Assessment of clinical outcomes and complications was conducted during follow-up evaluations.

Patient Population: Top of Form

The study enrolled a total of 34 patients who were diagnosed with sphenoid wing meningiomas as their primary medical condition. These patients were chosen following particular standards and included in the research cohort.

Inclusion Criteria

Patients between the ages of 20 and 65 who had sphenoid wing meningiomas as their primary medical diagnosis met the study's inclusion criteria. These individuals were chosen because of their verified diagnosis of sphenoid wing meningiomas and their age falling within the designated range.

Exclusion Criteria

Those who are over 65 or younger than 20, as they do not fit within the designated age range. Patients with diagnoses unrelated to sphenoid wing meningiomas or other forms of intracranial malignancies. The situations in which sphenoid wing meningioma diagnosis is unclear or not supported by suitable diagnostic techniques. Individuals who have received prior treatment for sphenoid wing meningiomas should be excluded from the study since their participation could skew the findings. The people whose major medical issues or comorbidities may have an impact on how study results are interpreted or their capacity to engage in the research.

Surgical Procedure

To maximize access for the surgical team, patients with sphenoid wing meningiomas were usually placed supine on the operating table with their heads slightly elevated and turned to the side

opposite the tumor. The head was also placed in a Mayfield head holder or a similar device to ensure stability during the procedure. This allowed the neurosurgeon to access the surgical site and perform the necessary maneuvers with optimal visibility and control. Sterilization of the surgical site was carried out to reduce the risk of infection. A scalpel was used to make an incision on the patient's scalp, exposing the underlying skull. The incision was usually linear or curved. Using a high-speed drill and specialized tools, a bone flap was produced in the skull to allow access to the brain and tumor. The tumor was gently exposed by carefully prying open the dura mater, the strong outer layer enclosing the brain. The brain, blood arteries, and cranial nerves were among the things the neurosurgeon peeled away from the tumor as he located and removed it. Throughout the process, suction, specialized tools, temporary clips, and coagulation devices were used to control bleeding. To guarantee a firm closure once the tumor was removed, the dura mater was painstakingly fixed with surgical patches or sutures. The bone flap was reinstalled and fastened with screws, plates, or other fasteners. Sutures or staples were used to close the scalp incision in layers, and a sterile dressing might have been used to aid in the healing process. The patient's vital signs were constantly watched during the treatment to make sure they were safe and doing well. The patient was moved to the recovery area following surgery so they could get close observation and postoperative treatment.

Postoperative Care

Postoperative care entails keeping a constant eye on vital signs, controlling discomfort, and looking for infection at the location of the incision. Patients are given fluids, nutritional assistance, and gentle encouragement to move around. Neurological assessments ensure early detection of any complications. Medications are administered as prescribed, and follow-up appointments are

scheduled to monitor progress and address concerns.

Data Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) software version 26. Descriptive statistics were employed for data assessment.

RESULTS

Gender Ratio and Age

Among the 34 patients, 25 (73.6%) were females and 9 (26.4%) were males. The mean age of our study was 47 ± 5 years.

Presenting Sign and Symptom

Among the 34 patients, 27 (79.4%) reported experiencing persistent headaches, 21 (61.7%) had seizures, 16 (47%) exhibited gradual progressive visual impairment in one eye, 14 (41.2%) showed signs of cognitive decline, and 8 (23.5%) had deficits in extraocular movement. Additionally, 7 patients (20.5%) presented with hemiplegia or hemiparesis, 6 (17.6%) displayed proptosis, and on fundoscopic examination, 2 (5.8%) showed signs of optic atrophy, while 2 had papilledema.

Table 2: Tumor Distribution by Location.

Tumor Distribution by Location	No. of Patients	Percentage
En-plaque SWM	03	8.8%
Pterional SWM	07	20.5%
Alar SWM	15	44%
Clinoidal SWM	09	26.4%

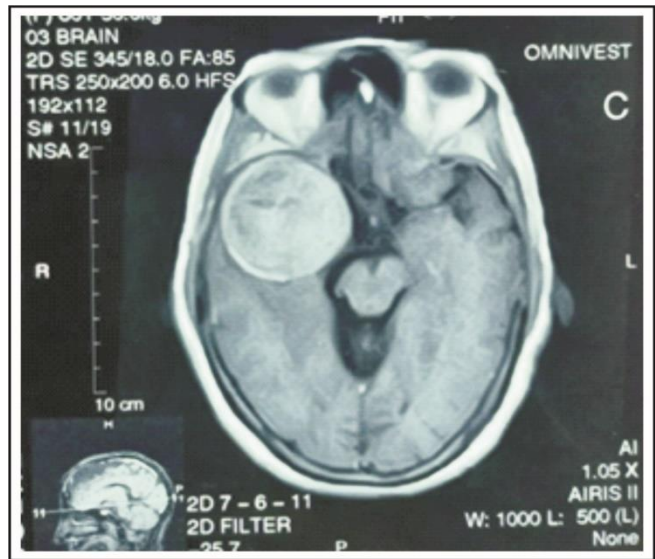


Figure 1: It shows Axial T1 MRI with contrast showing Right Sphenoid wing meningioma. (Picture included with patient’s consent).

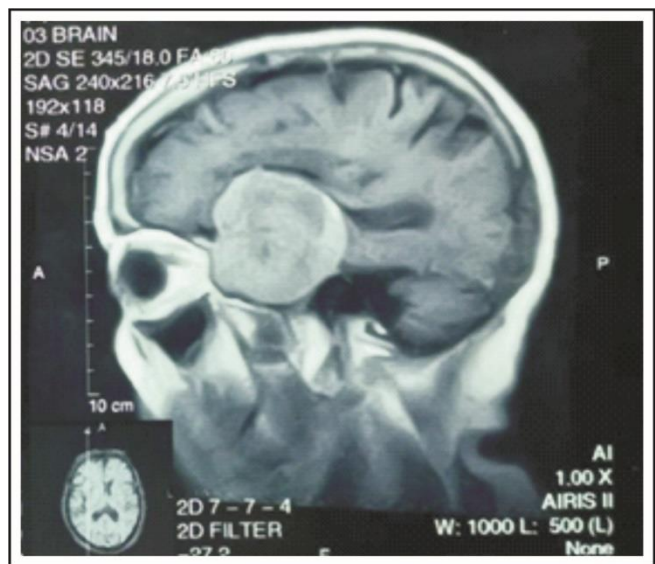


Figure 2: It shows Sagittal T1 MRI with contrast showing Right Sphenoid wing meningioma. (Picture included with patient’s consent).

Table 1: Presenting Signs and Symptoms.

Symptoms and Signs	Frequency	Percentage
Headache	27	79.4%
Seizures	21	61.7%
Visual Disturbance	16	47%
Cognitive Decline	14	41.2%
Extraocular Movement Deficit	08	23.5%
Motor Deficit	07	20.5%
Proptosis	06	17.6%
Papilledema	02	5.8%
Optic Atrophy	02	5.8%

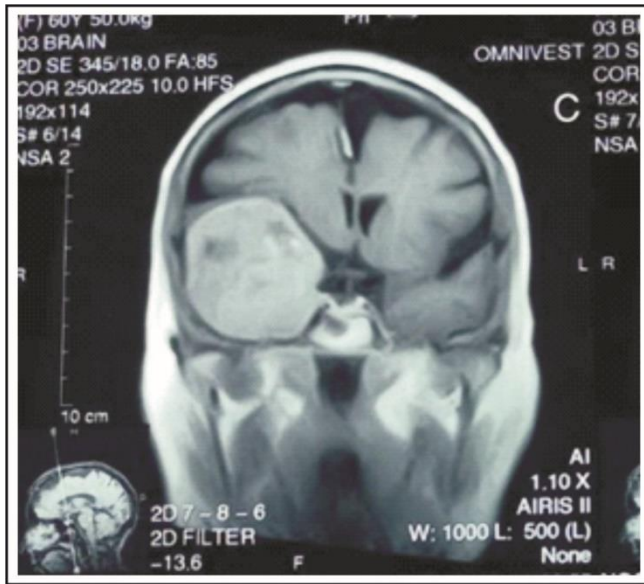


Figure 3: It shows Coronal T1 MRI with contrast showing Right Sphenoid wing meningioma. (Picture included with patient's consent).

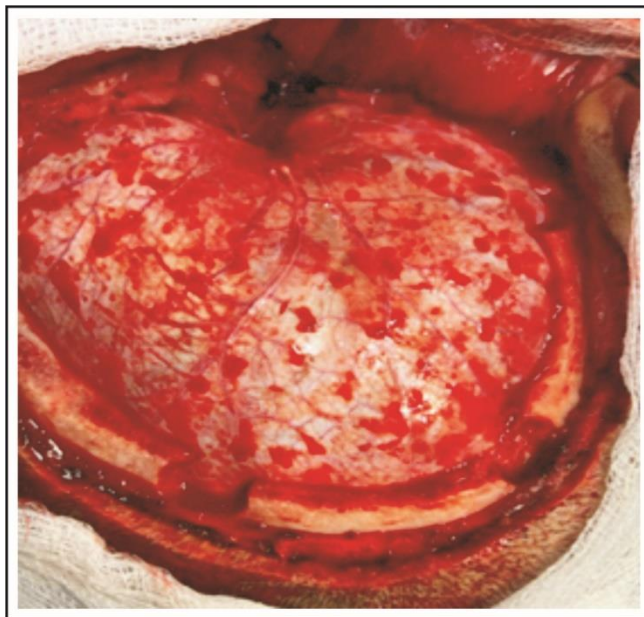


Figure 4: It shows the Dura has been exposed after craniotomy (Image used with patient's family consent).

Surgical Outcome of Sphenoid Wing Meningioma

The surgical results of sphenoid wing meningioma encompassed improvements in post-operative neurological function, seizure management, and

cognitive enhancement, with quality of life assessed using the Karnofsky Performance Scale (KPS). Notably, both the Pterional and Extended Pterional approaches yielded notably positive outcomes, with 28 patients (83%) experiencing relief from headaches, 14 patients (41%) showing improved visual symptoms, and 26 patients (74%)

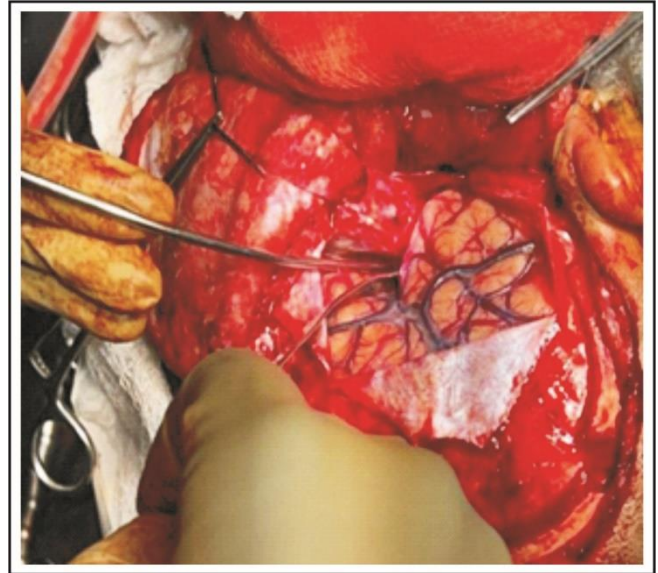


Figure 5: It shows the Sylvian fissure (Image used with the patient's family's consent).

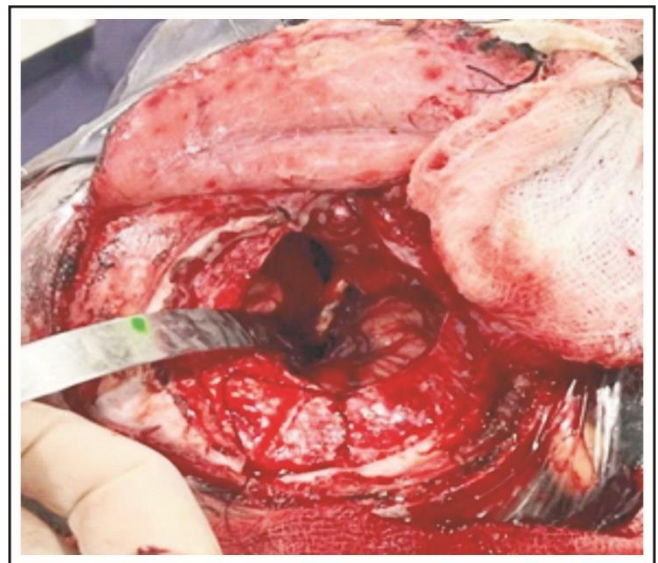


Figure 6: It shows the tumor bed after resection of the meningioma. (Image used with patient's family consent).

Table 3: Surgical Outcomes of Different Types of Sphenoid Wing Meningioma.

Tumor	No. of Patients	Gross Total Resection	Remission of Symptoms	Surgical Outcomes
En-plaque SWM	03	66.7%	66.7%	Visual enhancement in 2 patients Proptosis improved in all 3 patients
Pterional SWM	07	99%	85.7%	Visual enhancement in 4 patients Motor improvement in 3 patients Seizure control in 5 patients Motor improvement in 5 patients
Alar SWM	15	80%	86.6%	Cognitive improvement in 3 patients Seizure control in 9 patients 1 patient expired due to raised ICP
Clinoidal SWM	09	44.4%	66.6%	Visual enhancement in 2 patients Visual deterioration in 1 patient Extra-ocular movement deficits in 3 patients 2 patients expired due to hemorrhage

achieving seizure control, although 26% still reported occasional seizures. Additionally, motor function improved in 12 patients (35%) based on motor scale assessments.

Complications and Their Management

Despite the favorable outcomes observed with both the Pterional and Extended Pterional approaches in our study, we also noted several complications, both during and after surgery. The most common postoperative complication was hematoma formation, occurring in 4 patients (11.8%), with one presenting extradural hematoma and three exhibiting hematoma at the tumor bed.

Among these cases, two patients required hematoma evacuation, one underwent VP shunt placement on the opposite side, and another underwent decompressive craniectomy. Fortunately, all patients survived. Additionally, CSF leak was observed in 3 patients (8.8%), and cognitive decline was noted in the same number of patients. Motor neurological deterioration occurred in 4 patients (11.7%). Two patients (5.8%) experienced superficial wound infections. The overall mortality rate was 11.7% (4 patients), with two patients succumbing to hemorrhage and two others experiencing early postoperative mortality due to raised intracranial pressure.

Table 4: Complication and its Management.

Complications	No. of Patients	Percentage	Management
Post-op Hematoma	04	11.7%	02 patients needed evacuation of hematoma VP shunt was passed in 01 patient 01 patient had a decompressive craniectomy
Motor Deficit	04	11.7%	Permanent weakness in 03 patients 01 managed conservatively
CSF Leak	03	8.8%	The intervention was done on 02 patients
Cognitive Decline	03	8.8%	Behavioral changes and irrelevant talks
Superficial Wound Infection	02	5.8%	Debridement of wound
Mortality	04	11.7%	02 – Due to hemorrhage 02 – Due to raised ICP

DISCUSSION

In today's advanced era of Neurosurgery, despite significant progress, sphenoid wing meningiomas (SWMs) remain a formidable surgical challenge, particularly concerning medial and giant lesions. Gross total resection of these tumors is generally favored for optimal surgical outcomes in most cases of meningiomas within the middle cranial fossa. The primary objective of resection is to arrest tumor progression, alleviate existing symptoms, and minimize morbidity and mortality.

In our study involving 34 patients with sphenoid wing meningioma, we observed a higher prevalence among females, accounting for 73.6% of cases, compared to males at 26.4%. This gender distribution aligns with findings from previous studies by Mirone et al. and Ringel et al, which reported a female-to-male ratio ranging from 4:1 to 7:1 in certain series. The mean age of our patients was 47 ± 5 years, consistent with similar studies such as the one conducted by Simas et al., which reported a mean age of 52.2 years.

Our findings also shed light on the healthcare-seeking behavior of patients in our setting, where many initially seek symptomatic relief from local clinics without proper referral to specialized departments. This delay in diagnosis and referral underscores the importance of efficient patient referral practices for timely intervention and improved prognosis.

Headache was the most common presenting symptom, reported by 79.4% of our patients, contrasting with the findings of Hatam et al, who reported headaches in approximately 50% of cases. Additionally, 47% of our patients presented with visual deterioration, similar to the study by Ore et al., which reported visual symptoms in around 52% of cases. Notably, one patient in our study exhibited Foster-Kennedy syndrome, often associated with aggressive sphenoid wing meningiomas.

Proptosis was observed in 14.7% of our patients, a higher prevalence compared to the

study by Badry et al., where approximately 4.26% of patients presented with proptosis. Seizures were reported by 32.4% of our patients, contrasting with the findings of Balasa et al, who reported seizures in 9.5% of cases. Similarly, cognitive impairment was present in 41% of our patients, comparable to the study by Balasa et al., which reported cognitive impairment in approximately 46% of cases, often attributed to frontal lobe involvement.

Diagnostic imaging with MRI Brain with contrast facilitated accurate diagnosis, revealing various tumor distributions: En plaque SWM (8.8%), Pterional SWM (20.5%), Alar SWM (44%), and Clinoidal SWM (26.4%). These findings differ slightly from those reported by Balasa et al., where 43% of patients had medial meningiomas, 28.5% had alar meningiomas, and 28.5% had pterional meningiomas.

Approximately 35% of SWMs in our study were large to giant (>5 cm) due to delayed presentation to the Neurosurgery clinic, compared to 25% reported by Balasa et al. We primarily utilized the pterional approach for middle or lateral meningiomas, while extended pterional craniotomy was preferred for inner or clinoidal meningiomas, as supported by Lynch JC. Et al., who demonstrated excellent results with this approach for excision of Clinoidal SWMs. Additionally, varying degrees of extradural sphenoidal ridge removal were performed using microsurgical techniques.

CONCLUSION

The outcomes of sphenoid wing meningiomas hinge significantly on the chosen surgical approach and the proficiency of the surgical team. Employing the appropriate surgical technique plays a pivotal role in achieving adequate tumor resection. Our study concludes that utilizing a Pterional craniotomy for microsurgical excision of sphenoid wing meningioma proves to be highly effective and safe, resulting in favorable clinical outcomes such as resolution of headache, visual

impairment, cognitive decline, and seizures. Despite the favorable outcomes associated with the Pterional and extended Pterional approaches, it's important to note that the procedure still carries inherent risks and potential complications.

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Additional Information:

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Ethical Review Board Approval: The study was approved by the ethical review board.

Human Subjects: Consent was taken from all patients/participants in this study.

Conflicts of Interest:

In compliance with the ICMJE uniform disclosure form, all authors declare the following:

Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

Other Relationships: All authors have declared that there are no other contacts or activities that could appear to have influenced the submitted work.

Data Sharing Statement: For data sharing, interested researchers can contact the corresponding authors.

AUTHORS CONTRIBUTIONS

Sr.#	Author’s Full Name	Intellectual Contribution to Paper in Terms of:
1.	Aafaq Ahmad Qarnain Khalil	1. Study design, methodology & paper writing.
2.	Mumtaz Ali	2. Data collection and calculations.
3.	Akramullah	3. Analysis of data and interpretation of results.
4.	Sajid Khan, Zubair Bashir	4. Literature review and referencing.
5.	Mumtaz Ali	5. Editing and quality insurer.