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Anterior Clinoidectomy Enhances Tumour Resection And Visual Outcomes In Sphemnoorbital Meningioma En Plaque

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Abstract:

Background: *Spheno-orbital meningiomas (SOMs) are complex skull base tumors that often require extensive surgical resection to achieve favorable visual and cosmetic outcomes. Anterior clinoidectomy (AC) has been proposed as a method to improve surgical exposure and facilitate decompression of the optic nerve. This study investigates the effect of AC on visual and proptosis outcomes in 21 patients with SOM, 17 of whom underwent AC during tumor resection.*

Results: *This study investigates the impact of anterior clinoidectomy (AC) on visual function, proptosis reduction, and extent of resection in 21 patients undergoing frontotemporal approach for SOM. Patients were divided into two groups: Anterior Clinoidectomy (AC) group (n=17) and Non-Anterior Clinoidectomy (Non-AC) group (number=4). Our findings indicate that Anterior Clinoidectomy significantly improves visual and ocular motility outcomes, provides superior proptosis resolution, and facilitates more complete tumor resection, suggesting a vital role for AC in optimizing surgical outcomes for sphenoorbital meningioma.*

Conclusions*: Anterior clinoidectomy, when performed via a frontotemporal approach, offers significant advantages in the management of spheno-orbital meningioma en plaque. It enhances visual and ocular motor recovery, more effectively reduces proptosis, and enables greater tumor resection. These findings advocate for its routine use in appropriately selected cases to optimize functional and oncological outcomes.*

BACKGROUND:

Sphenoorbital meningiomas (SOMs) are a rare subtype of meningiomas that originate from the sphenoid wing and often invade the orbit, anterior clinoid process (ACP), optic canal, superior orbital fissure, and adjacent skull base structures.(1) They account for approximately 4–9% of all intracranial meningiomas and are more commonly seen in middle-aged females due to the hormonal sensitivity of meningioma cells.(1)

Clinically, SOMs are challenging due to their insidious growth and complex anatomical involvement.(2) The most frequent symptoms are progressive, unilateral visual loss and proptosis, followed by headache, diplopia, and periorbital pain. Visual impairment arises from tumor invasion and compression of the optic nerve within the optic canal or from ischemia due to vascular involvement. Proptosis results from intraorbital tumor extension and hyperostosis of the orbital walls.(3)

Radiologically, SOMs demonstrate a characteristic triad:

Meningioma mass with dural-based enhancement, Hyperostosis of the sphenoid wing and orbital walls, Intraorbital extension leading to extraocular muscle displacement.(4)

The mainstay of treatment is surgical resection. However, complete resection is often not feasible due to the risk of morbidity associated with tumor adherence to vital neurovascular structures (e.g., optic nerve, internal carotid artery, cranial nerves III–VI). As a result, maximal safe resection with decompression of critical structures remains the goal.(5)

The anterior clinoid process (ACP) is a bony prominence that forms the superolateral boundary of the optic canal.(6)

In cases where the tumor extends into the optic canal or causes compression of the optic nerve, removal of the ACP—termed anterior clinoidectomy—allows:

- Direct decompression of the optic nerve,

- Early identification and protection of the optic nerve,
- Expanded surgical corridor to the parasellar and orbital apex regions.(7)

Despite these theoretical advantages, anterior clinoidectomy is technically demanding and carries potential risks including cerebrospinal fluid (CSF) leak, injury to the optic nerve or internal carotid artery, and prolonged operative time. Therefore, its use remains controversial, and many surgeons weigh the risks and benefits on a case-by-case basis.(8)

Several studies have suggested that anterior clinoidectomy may significantly improve visual outcomes and reduce proptosis, particularly when optic canal invasion or tight bony confines are present. However, comprehensive data comparing outcomes in patients who undergo anterior clinoidectomy versus those who do not remain limited.(9)

This study presents analysis of 21 patients with sphenoorbital meningiomas treated surgically at our institution. We aim to evaluate whether anterior clinoidectomy positively impacts postoperative visual function and cosmetic outcomes—specifically, improvement in proptosis—compared to surgeries in which the ACP was preserved.

METHODS:

This cohort prospective study comprised patients who were hospitalized to and treated at the neurosurgery department of Assiut University Hospitals due to sphenoorbital meningioma throughout the time frame 2020 to 2024, following our local ethics committee's permission (IRB number 17200558). The patients or their first degree relatives signed an informed consent form. Regardless of age, we included individuals with a diagnosis of sphenoorbital meningioma with proptosis. We excluded those with proptosis due to other causes than sphenoorbital meningioma as orbital fibrous dysplasia and Non hyperostotic sphenoid wing meningioma.

We used the patient files to collect data about the clinical presentation like proptosis, visual affection trigeminal paresthesia and diplopia and entered them in the designed forms.

All patients underwent neuro-ophthalmological evaluations before surgery. Visual acuity (VA) was assessed using the Snellen chart. Preoperative visual function was classified into three groups: normal (6/6), mildly impaired (6/9–6/30), and severely impaired (6/60 or worse).

Neuro-radiological assessments were conducted for all patients using brain computed tomography (CT) and magnetic resonance imaging (MRI) scans. High-resolution CT scan were utilized to evaluate the extent of hyperostosis in the sphenoid wing, orbital walls, optic canal and superior orbital fissure. Gadolinium-enhanced MRI sequences were performed to identify intradural, intraorbital, or extracranial tumor portions and to assess the involvement of dura mater.

"The patients were divided into two groups based on the surgical approach: those who underwent anterior clinoidectomy (AC group, n = 17) and those who did not (non-AC group, n = 4)."

The surgical approach used in all our patients was the frontotemporal approach.

Outcomes Measures in the two groups.

a - Visual outcomes:

1 - Visual acuity (Snellen chart): improved, stable, deteriorated.

2 - Ocular motility.

b - Proptosis Index (PI) oucomes.

It was measured to all patients pre and early post-operative within 48 hours to evaluate proptosis outcomes and their correlation with changes in visual function.

Patients were categorized into three groups based on their proptosis index scores: mild proptosis (<1.3), moderate proptosis (1.3 to 1.7) and severe proptosis (> 1.7).

c - Resection extent: Simpson grades I–II (gross total resection), III–IV (subtotal resection).

The main approach we used to achieve a maximum safe resection was frontotemporal approach.

RESULTS:

According to our inclusion and exclusion criteria, 21 patients (pts) with sphenoorbital meningioma were included in this study. The demographic data of our patients are shown in (Table1). The age of the patients ranges from 27 to 55 years old with mean age 39 years. eighteen patients were female and three were male.

Table 1: demographic data of the patients in our study:

		Frequency	Percent
sex	**female**	18	85.7%
	male	3	14.3%
	Total	21	100%
age	< 30	2	9.5%
	30 : 40	10	47.6%
	>40	9	42.9%

The main presentation was proptosis, which was detected in all patients in varying degrees. visual acuity affection was reported in 14 patients (66.6%) (table 2), while oculomotor nerve palsy was detected in 4 patients and abducens nerve palsy was detected in 2 patients (table 2).

Visual acuity improved postoperative in 10 patients out of 14 patients who had visual affection pre-operative.

Oculomotor nerve palsy improved post-operative in two patients, and abducens nerve palsy improved in one patient.

Table (2) pre and post-operative clinical manifestations:

		Preoperative		Postoperative
Visual acuity	Normal(6/6)	7	Improved	10
	Mild(9/6:30/6)	12	The same	9
	Severe(60/6 or worse)	2	deteriorated	2
oculomotor Nerve palsy	Present	4	Present	2
	abscent	17	abscent	19
Abducens Nerve palsy	present	2	present	1
	abscent	19	abscent	20

According to preoperative proptosis index, five patients had mild proptosis, fifteen patients had moderate proptosis and one patient had severe proptosis. (Table 3).

Postoperative proptosis index showed regression in the index from moderate and severe proptosis to mild proptosis (mild = 15 patients, moderate = 6 patients). (Table 3).

Table (3) Proptosis index pre and post-operative:

	Preoperative PI	Postoperative PI
Mild <1.3	5	15
Moderate 1.3 : 1.7	15	6
Severe >1.7	1	0

Footnote:
PI: proptosis index.

Anterior clinoidectomy was done in 17 patients extradurally (80.95%). Figure 14.

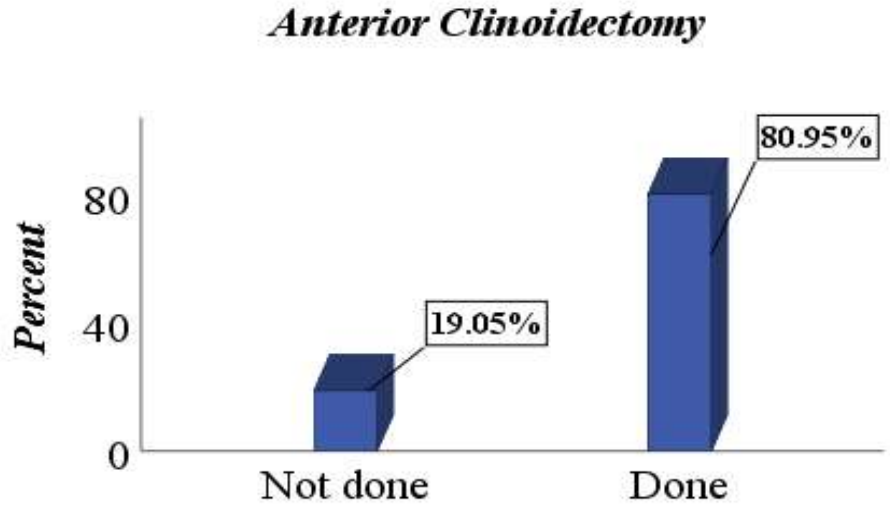

Figure 1. shows the anterior clinoidectomy percentage

To evaluate the impact of anterior clinoidectomy (AC), we assessed three key measures: visual outcome (including visual acuity and ocular motility), proptosis index, and extent of tumor resection.

1. Visual Outcome:

- Preoperative visual impairment was present in 14 of 21 patients (66.7%).
- In the AC group, 12 patients had preoperative visual loss; 10 (83.3%) improved postoperatively.
- In the non-AC group, 2 had preoperative visual loss; neither improved.
- Ocular motility disturbances were present in 2 AC patients (both fully recovered) and 2 non-AC patients (1 recovered).

Table 4: Pre- and Postoperative Visual Acuity Outcomes of AC and Non AC group.

Group	Patients with Preoperative Visual Impairment	Patients with Postoperative Improvement	% Improved
AC Group	12	10	83.3%
Non-AC Group	2	0	0%
Total	14	10	71.4%

Abbreviations:
AC – Anterior Clinoidectomy

Table 5: Ocular Motility Outcomes in AC vs. Non-AC Groups

Group	Patients with Preoperative Motility Disturbance	Full Postoperative Recovery	Partial/No Recovery
AC (n = 17)	2	2	0
Non-AC (n = 4)	2	1	1

2 - Proptosis Index

In the AC group (n = 17), preoperative proptosis was mild in 3 patients (17.6%) and moderate in 14 (82.4%), with no cases of severe proptosis. Postoperatively, the proptosis index shifted toward improvement, with 14 patients (82.4%) classified as mild and only 3 (17.6%) remaining moderate.

In contrast, the non-AC group (n = 4) had 2 patients with mild proptosis, 1 moderate, and 1 severe preoperatively. After surgery, 3 patients had mild and 1 had moderate proptosis, with no remaining severe cases.

Table 6: Proptosis Index Distribution in AC and Non-AC Groups (Preoperative vs. Postoperative)

Group	Proptosis Grade	Preoperative (n)	Postoperative (n)
AC Group (n = 17)	Mild	3	14
	Moderate	14	3
	Severe	0	0
Non-AC Group (n = 4)	Mild	2	3
	Moderate	1	1
	Severe	1	0

3 - Tumor Resection in both groups.

Total resection was achieved in 15 of 21 patients (71.4%).

Of these, 14 patients (93.3%) were in the AC group, and only 1 patient (6.7%) was in the non-AC group.

Incomplete resection occurred in 6 cases:

3 patients in the AC group

3 patients in the non-AC group

Table 7: Extent of Tumor Resection in AC vs Non-AC Groups

Resection Type	Total Cases (n=21)	AC Group (n=17)	Non-AC Group (n=4)
Total Resection	15	14	1
Incomplete Resection	6	3	3

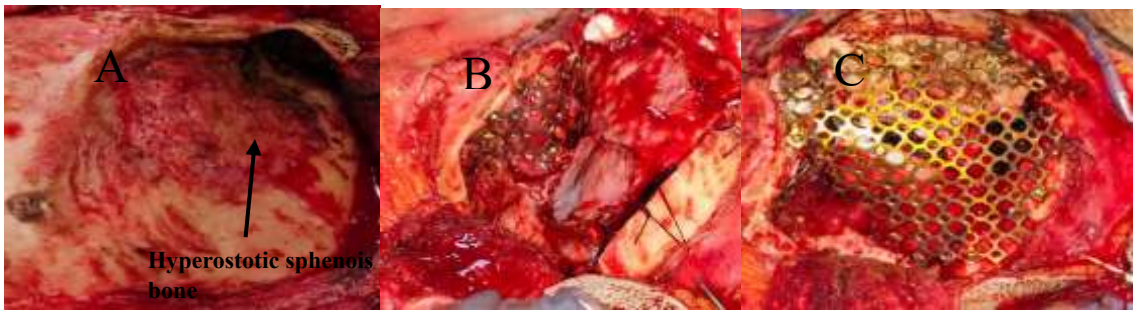

Figure 2: (A) pterional (fronto-temporal approach) showing hyperostotic sphenoid bone. (B) reconstruction of orbit with titanium mesh after drilling of hyperostotic orbital bone. (c) reconstruction of drilled hyperostotic sphenoid bone with titanium mesh.

DISCUSSION:

We operated on 21 patients who had sphenoorbital meningioma with proptosis. Their ages ranged from 27 to 55 years, with a mean age of 39 years.

We had 18 females (85.7%) and 3 males (14.3%) in our study. This is consistent with the fact that meningioma's have female predominance.(10)

This is similar to the study by Florian and colleagues, in which there were 63 patients, with 50 (80%) females and 13 males (20%).(11)

This study evaluated the impact of anterior clinoidectomy (AC) on surgical outcomes in patients with spheno-orbital meningioma (SOM) en plaque, focusing on three key parameters: visual outcome, proptosis index, and extent of tumor resection. Our findings suggest that anterior clinoidectomy is associated with improved functional and anatomical outcomes across all measures.

1. Visual Outcome

Visual acuity was compromised preoperatively in 14 of the 21 patients. Among the 17 patients who underwent AC, 12 had preoperative visual disturbances, and 10 of these (83.3%) showed postoperative improvement. In contrast, only 2 of the 4 non-AC patients had visual impairment preoperatively, and neither demonstrated significant improvement postoperatively.

Ocular motility was affected in 2 patients in the AC group, both of whom showed full recovery following surgery. In the non-AC group, 2 patients also presented with preoperative motility disturbance, but only one experienced postoperative improvement. These findings support the hypothesis that anterior clinoidectomy, by enabling wider exposure and more complete decompression of the optic canal and orbital apex, can lead to better recovery of visual function and extraocular muscle dynamics.

2. Proptosis Index

The severity of proptosis was evaluated pre- and post-operatively. In the AC group, proptosis was mild in 3 and moderate in 14 patients preoperatively, with no cases of severe proptosis. Postoperatively, 14 patients showed mild and 3 remained moderate, reflecting a clear improvement. In the non-AC group, proptosis was mild in 2, moderate in 1, and severe in 1 patient preoperatively. Postoperatively, 3 patients had mild proptosis and 1 remained moderate, with no severe cases remaining. While both groups showed improvement, the AC group exhibited a more uniform and consistent shift toward milder grades, suggesting that anterior clinoidectomy contributes to more effective orbital decompression, likely due to a more extensive removal of hyperostotic bone and tumor tissue around the orbital apex.

3. Extent of Resection

Total resection was achieved in 15 of 21 cases (71.4%), with 14 of these in the AC group (82.4%) and only 1 in the non-AC group (25%). Incomplete resection occurred in 3 patients in the AC group and 3 in the non-AC group. This significant difference underscores the technical advantage of AC in allowing greater exposure of the tumor around the optic canal, anterior clinoid process, and orbital structures, thereby facilitating more complete resection without increased morbidity

We performed frontotemporal approach in all 21 patients. The advantages of frontotemporal approach include that it facilitates the extradural drilling of the anterior clinoid process, the decompression of the optic canal and the superior orbital fissure and provides a good access to the orbit and middle fossa (12).

Performing aggressive surgical resection has been debatable. It was established that gross total resection with Simpson grade 1 the main standard to achieve good outcomes, but this is accompanied by multiple cranial nerve palsies post-operative. Symptomatic improvement is the main aim of surgery recently, compared to gross total resection, which was usually used.

CONCLUSION:

Our study demonstrates that anterior clinoidectomy significantly contributes to improved surgical and functional outcomes in patients with spheno-orbital meningioma en plaque. By enhancing exposure of the optic canal, orbital apex, and surrounding hyperostotic bone, AC enables more effective decompression, leading to better recovery of visual acuity and ocular motility. Additionally, it facilitates more complete tumor resection and greater reduction of proptosis. These findings support the incorporation of anterior clinoidectomy as a valuable component of the surgical strategy for SOM, particularly in cases involving optic nerve compression or extensive orbital involvement.

List of abbreviations:

- SOM: Sphenoorbital Meningioma.
- ACP: Anterior Clinoid Process
- CSF: Cerebrospinal Fluid
- VA: Visual Acuity.
- CT: Computed Tomography.
- MRI: Magnetic Resonance Imaging.

- AC: Anterior Clinoidectomy
- Non-AC: Non-Anterior Clinoidectomy
- PI: proptosis Index.

Limitations and Future Directions

This study is limited by its relatively small sample size. Future prospective studies with larger cohorts and standardized follow-up protocols are warranted to validate these results. Advanced imaging and intraoperative navigation may further optimize patient selection for anterior clinoidectomy and improve surgical planning.

Declarations:

Ethics approval: this study was approved by institutional review board of the faculty of medicine in assiut university, assiut, Egypt. The date of original approval was 18 - 3 – 2021, with reference number 17200558.

The study was conducted in accordance with the ethical standards of the declaration of Helsinki. Ethics approval was obtained from the institutional review board of the faculty of medicine in assiut university. The patients or their first degree relatives signed an informed consent form.

The study did not involve any individual personal data or identifiable information. Therefore, consent for publication is not applicable.

Data availability statement: the data supporting the findings of the study are available upon reasonable request from the corresponding author. Due to privacy restrictions, the date cannot be shared publicly. However, access to the data may be granted upon request and subject to any conditions.

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All figures used are original and mine.

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