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ORIGINAL ARTICLE

Evaluation of Outcome of Surgical Management of Cranio-orbital Mass Lesions

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ABSTRACT

Background: The goal of surgical resection of cranio-orbital tumors is to effectively treat the underlying pathology and correct the proptosis, which, if ineffectively corrected, can lead to cosmetic and functional disability. This study aimed to quantitatively assess the degree of pre-and postoperative proptosis and determine the outcome of surgical resection of cranio-orbital tumors.

Methods: All cranio-orbital surgical resections causing proptosis between 2019 and 2021 were reviewed. The extent of proptosis was measured by the exophthalmos index (EI). EI was calculated as the ratio of the distance of the anterior limit of each globe to a line drawn between the anterior limit of the zygomatic frontal processes, comparing the pathological eye to the normal one. Also, Snellen's chart was utilized to assess vision. Postoperative radiographic measurements were assessed 3 months following surgery to allow surgical swelling to subside.

Results: A total of twenty-four patients (18 females and 6 males, with a mean age of 39.7±10.67 years) were surgically treated for proptosis associated with cranio-orbital tumors. Of them, fourteen patients harbored meningiomas (spheno-orbital meningioma), four with intraconal cavernous hemangioma, two with fibrous dysplasia, and one patient each with chondrosarcoma, histiocytosis X, optic nerve glioma and osteoid osteoma. Surgical approaches included lateral orbitotomy, subfrontal with orbitotomy, frontotemporal, and modified one-piece orbitozygomatic approach. All cases of bone destruction underwent reconstruction of orbital walls and temporal bone. Preoperative EI averaged 1.87±0.38 (range 1–2.7), while the EI decreased to a mean of 1.37±0.3, postoperatively. **Conclusions:** Proptosis associated with cranio-orbital pathology represents a surgical challenge. The EI is a reliable quantitative measure for the assessment of proptosis. Transcranial surgery, maximal tumor removal, and correction of proptosis can improve cosmetic appearance with better outcomes.

Keywords: Proptosis; Cranio-orbital; exophthalmos index

INTRODUCTION

The orbit can be described as a cone-shaped space with a quadrangular base. Its apex consists of the superior orbital fissure alongside the optic canal. The optic canal contains the optic nerve and ophthalmic artery. The superior orbital fissure is the gateway for the 3rd cranial nerves, branches of the 1st division of the trigeminal nerve, sympathetic fibers from the cavernous sinus, and superior ophthalmic vein[1]

The orbit is anatomically a quite small space. However, the different structures located within its cavity are frequently the site of origin of numerous tumors and tumor-like lesions, in either adults or children. Clinical manifestations are proptosis, visual disturbances, weakness of extraocular muscles, and ocular pain[2]

Advances in imaging and surgical approaches have significantly changed the management of orbital disease. The traditional microsurgical approaches are now complemented by minimally invasive surgeries and reconstructive procedures for managing orbital lesions and hold the potential to reduce morbidity[3]

Intracranial and orbital pathology manifested by proptosis represents a surgical challenge. Management of these patients requires achieving two goals: appropriately treating the target pathology and returning the eye to a normal position. Residual proptosis after treatment can lead to less favorable outcomes including cosmetic and functional disability[4]

METHODS

This study was done as a prospective study of 24 cases with orbital tumors or intracranial tumors extending to the orbit treated in the Neurosurgery department, at Zagazig University Hospitals, for two years duration (from August 2019 to September 2021) for evaluation of the surgical outcomes of cranio-orbital mass lesions excision. Patients were diagnosed by attending the neurosurgical outpatient or referred by other physicians.

Written informed consent was obtained from all participants, the study was approved by the research ethical committee of the Faculty of Medicine, Zagazig University. The study was conducted according to the Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

After meeting with a member of the operating team for a detailed explanation of the hospital course, including preoperative preparation, the nature of the surgical procedure, possible complications in detail, the postoperative course, and expected prognosis and outcome, all patients underwent complete neurological and ophthalmological examination including degree of proptosis and visual acuity. Preoperative images were done including CT and/or MRI with contrast.

The principle of choosing appropriate surgical approach was done according to the localization of the lesion in the pre-operative image and using a “clock model” of the orbit with the optic nerve in the center [5]. Every surgical corridor done avoided crossing the plane of the optic nerve, while providing adequate exposure to the pathology (Fig 1). Surgical approaches included a frontotemporal approach with orbital osteotomy, lateral microorbitotomy, modified one-piece orbitozygomatic approach, and subfrontal approach with orbitotomy.

Visual acuity was measured using the Snellen chart. The preoperative visual functions were categorized into three grades: normal (6/6), mildly impaired (6/9–6/18–6/24–6/36), and lastly, severely impaired (6/60 or worse).

The exophthalmos index (EI), first described by **Scarone et al.**, was used to measure the extent of proptosis. The EI (Fig 2) is calculated as the ratio of the distance of the anterior limit of each globe to a line drawn between the anterior margin of the frontal processes of the zygomas, comparing the diseased eye to the normal eye. The frontal process of the zygoma is a reliable landmark in the neurosurgical society and is rarely involved in pathology. There were no cases in our study in which the frontal process of the zygoma was affected by pathology. The normal position of the eye correlates to an EI of exactly 1.0, with an EI greater than 1.0 indicating proptosis/exophthalmos and an EI less than 1.0 indicating enophthalmos. EI is measured in the pre- and postoperative images[6].

In cases of tumor-causing bone destruction/hyperostosis or any pathological changes requiring extensive bone removal, reconstruction was done to maintain normal orbital volume preventing post-operative enophthalmos. Reconstruction was done whether Periorbita was opened or not (Fig 3). Titanium mesh and/or methylmethacrylate were used in reconstruction of orbital walls and temporal bone.

STATISTICAL ANALYSIS

All data were collected, tabulated, and statistically analyzed using SPSS 26.0 for Windows (SPSS Inc., Chicago, IL, USA). Quantitative data were expressed as the mean ± SD & median (range), and qualitative data were expressed as absolute frequencies (number) & relative frequencies (percentage).

RESULTS

Patients’ ages ranged from 17 to 55 years (mean, 39.7±10.67 years). Most of the study participants were females (n=18, 75%). Proptosis (23/24; 95.8%) and headache (17/24; 71%) were

the two most presented complaints, followed by visual impairment (16/24; 66.6%). One patient presented with fits and one with forehead swelling (Table 1). Proptosis, as measured by the EI, had a preoperative mean of 1.8±0.32. Ipsilateral visual affections were obvious in sixteen patients: visual loss in two patients, severe impairment (>6/36) in six patients, and mild impairment (6/9–6/18–6/24–6/36) in eight ones. The tumors were more likely detected on the left side than the right (16:8). Degree of removal of tumors ranged from 90 to 100% with a Mean ±SD (96.08±2.63). The most common locations for residual tumors were the cavernous sinus (CS), SOF, and OC. Histologic analysis was consistent with World Health Organization (WHO) Grade I meningioma in 14 of 24 (58.3%) tumors, cavernous haemangioma in 4 tumors (16.7%) (Fig 4), two fibrous dysplasia, and one tumor each was chondrosarcoma, histiocytosis X, optic nerve glioma and osteoid osteoma (4.2%) (Table 2). Postoperative imaging at 3 follow-up visits was available for all 24 patients. Postoperative EI had a mean of 1.28±0.26 with an average improvement of 0.52.

Postoperatively, proptosis improved in twenty-one (87.5%), remained static in two (8.3%), and worsened in one of the patients (Table 3). It was noted that the prognosis of proptosis was enhanced when adequate decompression of the orbital walls, particularly the lateral orbital, was achieved. None of our patients developed enophthalmos as a result of excessive bony or soft tissue decompression, as appropriate reconstruction was done in case of bony removal. The number of reconstructions done was 18 cases (75%).

Eleven patients (45.8%) improved in vision following surgery. Vision remained static in twelve patients (50%) and vision deteriorated in one (4.2%) in the postoperative period. The patient who deteriorated had tumor recurrence and was reoperated (Table 3). All the eleven patients who improved postoperatively were operated in the latter part of the series where we performed optic canal deroofing and anterior clinoid process drilling, regarding of their involvement in imaging or not.

No cases of mortality were reported in our study. One of our patients had to be reexplored for recurrence. New onset oculomotor nerve palsy was documented in two patients (8.4%), which persisted for the follow-up period. Transient Occipitofrontalis weakness was reported in 17 patients which improved in the 1-month follow-up visit, except for three cases that suffered permanent weakness. One patient developed postoperative CSF rhinorrhea and meningitis requiring rehospitalization and improved on medical treatment and was discharged.

Table 1: clinical Preoperative data of the studied group (n=24)

Characteristic	Category	Study group (n=24)	
		No.	%
Presenting symptoms	Proptosis	23	95.8
	Forehead Swelling	1	4.2
	Visual decline	16	66.6
	Headache	17	71
	Convulsions	1	4.2
Preoperative deficit	6th nerve palsy	1	4.2
	Visual Deterioration	14	58.3
	Visual Loss	2	8.3
	No Deficit	7	29.2

Table 2: frequency distribution of histopathological types of the removed tumors

Characteristic	Category	Study group (n=24)	
		No.	%
Histopathology	Cavernous Haemangioma	4	16.7
	Chondrosarcoma	1	4.2
	Fibrous dysplasia	2	8.3
	Histocytosis X	1	4.2
	Meningioma (WHO G1)	14	58.3
	Optic nerve glioma	1	4.2
	Osteoid osteoma	1	4.2

Table 3: frequency distribution of post-operative outcomes

Characteristic	Category	Study group (n=24)	
		No.	%
Proptosis	Improved	21	87.5
	Stationary	2	8.3
	Worsened	1	4.2
Visual outcome	Improved	11	45.8
	Unchanged	12	50.0
	Worsened	1	4.2
Post-operative enophthalmos	Cases detected	0	0

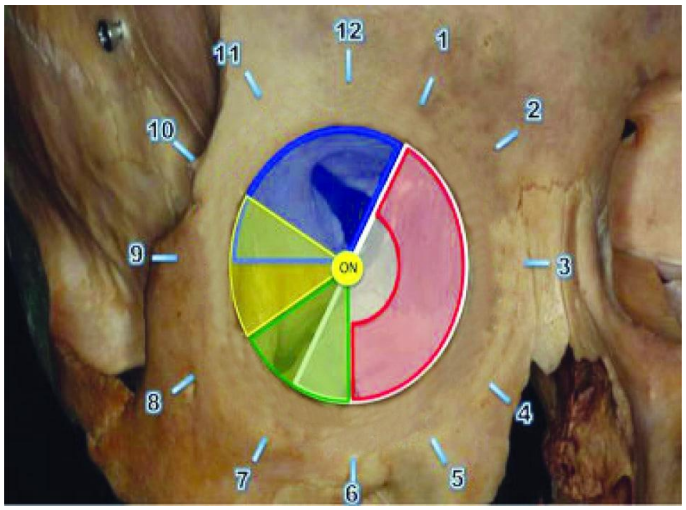

Figure 1: Illustration demonstrating 360-degree access to the right-sided orbit.[5]

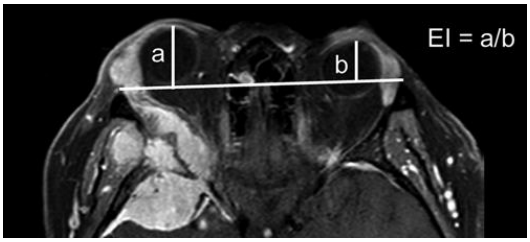

Figure 2: Calculation of the exophthalmos index (EI) as described by Scarone et al[6]

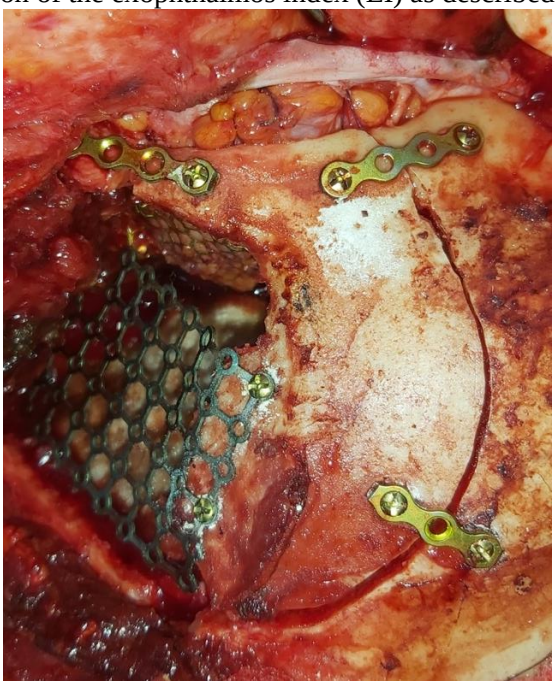

Figure 3: Demonstration of intra-op reconstruction results.

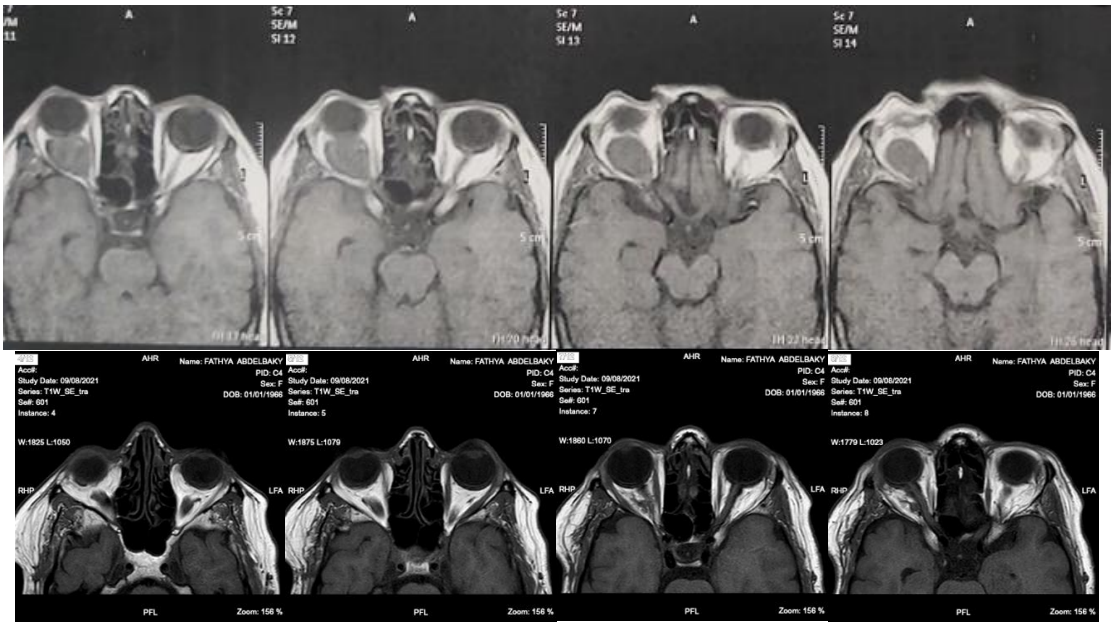

Figure 4: A) Pre-op MRI image of Rt orbital cavernous hemangioma. B) post-op MRI image showing complete tumor excision and correction of proptosis.

DISCUSSION

It is difficult to treat intracranial and orbital pathologies associated with proptosis. The degree of proptosis correction is dependent upon the removal of the primary pathology and the methods used for reconstruction[4]

Whether the orbit needs reconstruction remains debated in the literature. While some published series have stated that reconstructing the lateral orbital wall is not necessary[7]. others have reported that orbital reconstruction decreases postoperative complications, including ocular muscle paresis, pulsating exophthalmos/enophthalmos, and pseudo meningocele formation[8]. Reconstructing the sphenoid wing also decreases the cosmetic deformity due to temporal depression.

Meningioma was the most common pathological entity encountered among our patients representing 58.3% of total lesions. This ratio agreed with the published series[4,13,14,21,22,23] which also demonstrated meningioma as the most commonly encountered cranio-orbital tumor. Margalit et al reported a 17.3% incidence of osteoma[21], while in our study the incidence was 4.2%. Orbital chondrosarcoma is rare, with published reports of this tumor reaching 28 cases mentioned in the English-written literature mostly in adults[24]. In our study, one case was operated with a histopathological report confirming a diagnosis of mesenchymal chondrosarcoma.

Results of exophthalmos correction in the literature are reported inconsistently. The degree of proptosis correction is reported in most of the published studies in qualitative terms, with reported rates of proptosis correction ranging from 70%– 96%.[9,10,11,12]. The qualitative nature of the published data – despite providing valuable insight about the degree of correction – results in making direct comparisons of proptosis outcomes difficult when trying to compare different techniques. For these reasons, the use of the exophthalmos index (EI), which utilize a constant radiographic landmark rarely affected by the disease process, results in a simple, reliable, and reproducible data point that can be used to compare the results across different studies. Scarone et al., in their study on the surgical management of sphenoorbital meningiomas in which they developed the exophthalmos index, noted an initial EI of 1.8 with a median EI improvement of 0.4 at the first follow-up[6].

Thirty-three patients harboring sphenoorbital meningioma manifested with proptosis were treated by Bowers et al. over 13 13-year period and evaluated. The initial EI was calculated at 1.39 with an overall improvement of 0.26 at the latest evaluation visit.[13] Orbital reconstruction was not performed by this group because their experience showed that the periorbital tissues had a “hard” or “woody” consistency, resulting in limited the ability to achieve full proptosis correction, and preventing the occurence of postoperative enophthalmos. These authors separated the orbital contents from the adjacent anterior and middle cranial fossae dura with autologous fascia and fat grafting instead of reconstructing the orbital wall.[13]

Gonen et al. published their experience in the management of 27 cases of sphenoorbital meningiomas treated over 10 years with an initial EI average of 1.35 and subsequent improvement averaging 0.17. Their decision to reconstruct the orbital wall was based on the need to open the periorbita to resect the tumor: if the periorbita was violated, then reconstruction of the orbit was commenced.[14]

Freeman et al. reported their experience with 25 patients over 16 years with an average preoperative EI of 1.25 and an improvement in EI of 0.13 at the time of the latest follow-up. No orbital reconstruction was performed in this group[7]

In our study, the preoperative EI had a mean of 1.8±0.328 with an average reduction in EI of 0.52. These results show that we achieved good proptosis correction in our patient population. Our focus while removing orbital tumors with severe sphenoid wing involvement, was reconstructing the orbital walls removed (roof and lateral wall). Additional focus was placed on the reconstruction of the removed bone of the sphenoid wing and temporalis fossa to prevent postoperative temporal depression. We often use titanium mesh for reconstruction. We had zero cases of postoperative enophthalmos in our study.

Visual improvement following cranio-orbital tumor resection ranges from 17 to 77%.[16,17,18,19,20]. In line with our results,

numerous research works revealed that there was no significant association between any of the patient's characteristics (age, duration of symptoms, degree of proptosis, or surgical procedure) and the resultant visual outcome[15]. Gonen et al stated that preoperative visual deficit and optic canal involvement are important parameters affecting favorable outcome in visual function after surgical removal of sphenoorbital meningiomas[14]. In our study, we also found that decompression of the optic nerve is an essential step in cranio-orbital tumor surgery and is responsible for the favorable visual outcome, rather than the extent of tumor resection.

CONCLUSION

Proptosis associated with cranio-orbital pathology represents a challenge to surgeons. However, the EI would provide a reliable assessment tool for proptosis. In addition, orbital reconstruction in patients whose orbital walls are involved carries a favorable outcome reducing postoperative enophthalmos and other related complications.

CONFLICT OF INTEREST

None declared

FINANCIAL DISCLOSURE

None declared

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