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Original Article

Surgical treatment of orbital tumors in a single center: Analysis and results

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ABSTRACT

Background: Orbital tumors, arising within the bony orbit and its contents, present diverse challenges due to their varied origins and complex anatomical context. These tumors, classified as primary, secondary, or metastatic, are further subdivided into intraconal and extraconal based on their relationship with the muscle cone. This classification significantly influences surgical approach and management. This study highlights surgical experiences with orbital tumors, underscoring the importance of tailored surgical approaches based on the lesion's site and its proximity to the optic nerve.

Methods: This retrospective study at the National Institute of Cancer's Head and Neck Department (2005–2014) analyzed 29 patients with orbital tumors treated with surgery, radiotherapy, chemotherapy, or combinations of them. Patient demographics, tumor characteristics, and treatment responses were evaluated using computed tomography (CT), magnetic resonance imaging, and positron emission tomography-CT imaging. Malignant tumors often required orbital exenteration and reconstruction, highlighting the study's commitment to advancing orbital tumor treatment.

Results: 29 patients (18 females and 11 males, age 18–88 years, mean 53.5 years) with orbital tumors exhibited symptoms such as decreased vision and exophthalmos. Tumors included primary lesions like choroidal melanoma and secondary types like epidermoid carcinoma. Treatments varied, involving a multidisciplinary team for surgical approaches like exenteration, with follow-up from 1 to 9 years. Radiotherapy and chemotherapy were used for specific cases.

Conclusion: Our study underscores the need for a multidisciplinary approach in treating orbital tumors, involving various surgical specialists and advanced technologies like neuronavigation for tailored treatment. The integration of surgery with radiotherapy and chemotherapy highlights the effectiveness of multidimensional treatment strategies.

Keywords: Neuro-oncology, Orbital tumor, Retrospective study, Surgical outcome

INTRODUCTION

The orbital tumors originate from the bony orbit and its content and constitute a diversity of lesions with several forms of management.[10,22,36,42,54] The complexity of the bony structures around the orbit

and its structural conformation constitute a surgical region of interdisciplinary expertise. The microsurgical anatomy of the orbit is formed by continent, which is formed by the bone walls (frontal, zygomatic, maxillary, sphenoid, lacrimal, palatine, and ethmoid bones) and contents, which are constituted by eyeball, ocular muscles, fat, lacrimal gland, nerves, veins, and arteries.[31] Understanding this concept, orbital tumors are classified into three categories: (1) primary lesions, which arise from the orbital structures; (2) secondary lesions, are produced by direct extension to the orbit from intracranial tumors or tumors of the paranasal sinuses that by contiguity spread to involve the orbit; and (3) metastatic tumors.

Orbital tumors are divided anatomically into intraconal and extraconal; this classification is according to the relationship between the tumor and muscle cone.[10]

There are many studies of the orbital tumors about their origins and locations in the orbit,[38] review of orbital tumors,[10] survival patterns,[22] surgical management,[29,42,54] and orbital pathology.[36] Orbital tumors, arising within the bony orbit and its contents, present a multifaceted challenge in the field of surgical oncology due to their varied origins and complex anatomical context.[4] These tumors emerge from the intricate osseous and soft tissue structures of the orbit, an area that demands an interdisciplinary approach for effective management.[28]

Anatomically, orbital tumors are further subdivided into intraconal and extraconal categories. This distinction is based on the tumor's relationship with the muscle cone, a critical factor in determining the surgical approach and management strategy.[18] Extensive research has been conducted on orbital tumors, focusing on aspects such as their origins and specific locations within the orbit, comprehensive reviews of the various types of orbital tumors, patterns of survival following treatment, effective surgical management techniques, and the broader scope of orbital pathology. This body of research not only enriches our understanding but also guides the evolving practices in the surgical treatment of these complex lesions.[12,50]

The challenge in treating orbital tumors lies not only in the removal of the tumor itself but also in preserving the intricate functions and esthetics of the eye and surrounding structures. Therefore, a nuanced understanding of orbital anatomy, coupled with advances in surgical techniques and interdisciplinary collaboration, is essential for successful outcomes in the treatment of orbital tumors.[51] In this study, we display the surgical experience of orbital tumors, emphasizing the importance of each surgical approach according to the surgical goal, site, and location of the lesion in relationship with the optic nerve.

MATERIALS AND METHODS

This study presents a retrospective analysis conducted at the Head and Neck Department of the National Institute of Cancer, covering a period from 2005 to 2014. Inclusion criteria were (1) histological confirmation of tumor of the orbit, (2) having available radiological exams before and after treatment, and (3) comprehensive follow-up data. Twenty-nine patients with various types of orbital tumors fulfilled the inclusion criteria and were included in the study. Two patients were excluded from this study as they were lost to follow-up. These individuals underwent diverse treatment modalities, including surgical interventions, radiotherapy, chemotherapy, or a combination thereof. The treatment and subsequent monitoring of these patients were entrusted to a skilled multidisciplinary team comprising neurosurgeons, head-and-neck surgeons, plastic surgeons, ophthalmologists, and neuro-oncologists. This collaborative approach allowed for a holistic assessment and management of each case. Our evaluation process involved an in-depth examination of patient demographics and a thorough analysis of tumor characteristics. Diagnostic methodologies included the utilization of computed tomography (CT) scans, magnetic resonance imaging (MRI), and endoscopic biopsies. Follow-up assessments were conducted using CT, MRI, and positron emission tomography-CT (PET-CT) imaging to monitor disease progression and response to treatment. We categorized the patient population into three distinct groups based on tumor origin: primary lesions, secondary lesions, and metastatic tumors. The surgical management strategies were carefully tailored, considering several pivotal factors. These included the tumor's location relative to the optic nerve, guiding our choice of surgical approach (craniotomy for superior/lateral positions, endoscopic approach for medial/posterior positions, craniofacial approach, and/or endoscopy for inferior positions); the origin and size of the tumor; and the intended surgical goal, which ranged from biopsy and debulking to total resection.

The orbital tumors were further classified based on their positioning in relation to the muscle cone, categorized as either extraconal or intraconal. The intraconal space, encircled by the conus connecting the rectus muscles, was differentiated from the extraconal area, which lies outside the muscle cone and houses fat and the lacrimal gland. The selection of surgical technique (endoscopic, microscopic, or hybrid) was determined by the tumor's specific location. Neuronavigation technology played a vital role in all these procedures. The surgical techniques employed included the orbito-fronto-zygomatic approach or the orbito-fronto approach as per Zambraski's methodology, with the endoscopic endonasal technique reserved for biopsy and debulking procedures, particularly when tumors were situated medially and posteriorly in relation to the optic nerve. In instances of malignant tumors, orbital exenteration was performed, followed by adjunctive radiotherapy, chemotherapy, or a combination of both. This extensive procedure entailed the removal of all orbital contents,

including the globe, muscles, fat, and lids. Furthermore, when lesions involved the bony structures of the orbit and periorbit, orbital wall reconstruction was indicated. In cases of exenteration, patients were also fitted with ocular prostheses. This comprehensive and methodical approach underscores our commitment to advancing the understanding and treatment of orbital tumors. By integrating cutting-edge diagnostic techniques, nuanced surgical methods, and interdisciplinary collaboration, we strive to enhance patient outcomes in this complex and challenging field.

RESULTS

We studied 29 patients (18 females and 11 males) with ages ranging from 18 to 88 years (mean age 53.5 years). The major clinical manifestations were decreased visual acuity (39.28%), exophthalmos (39.28%), local pain (32.4%), ophthalmoparesis (17.8%), and amaurosis (14.28%). Among all patients 17 cases were primary tumors, 10 cases were secondary lesions and 2 cases were metastasis. The primary lesions were choroidal melanoma (9 cases), adenoid cystic carcinoma (2 cases), lymphoma (2 cases), and one single case of optic nerve sheath meningioma, primitive neuroectodermal tumor (PNET), plexiform neurofibroma and one mesenchymal chondrosarcoma; whereas secondary lesions were epidermoid carcinoma (3 cases), basal cell carcinoma (3 cases), one squamous cell carcinoma, one schwannoma, one sino-orbital osteoma, one rhabdomyosarcoma and two metastasis (clear cell renal cell carcinoma and osteoblastic osteosarcoma) [Figure 1a]. The follow-up ranged from 1 to 9 years, with an average of 4.7 years. The surgical management was done by a multidisciplinary team, which was performed in 20 patients: exenteration was performed in 12 (60%) patients, exenteration in addition to an orbitofrontal approach was performed in 3 (15%) patients, endoscopic biopsy in 2 (10%) patients, the craniofacial approach was performed in 2 (10%) patients, and pterional approach in 1 (5%) patient [Table 1 and Figure 1b]. To define the most effective and appropriate surgical approach for each patient, we critically revised each case. The management was with the endoscope when the site of the tumor was in the medial and posterior part in a relationship with the optic nerve; when the tumor was in the superior and lateral part of the optic nerve, the approach was a craniotomy; and when the tumor was situated inferior, the surgical approach was performed a craniofacial approach.

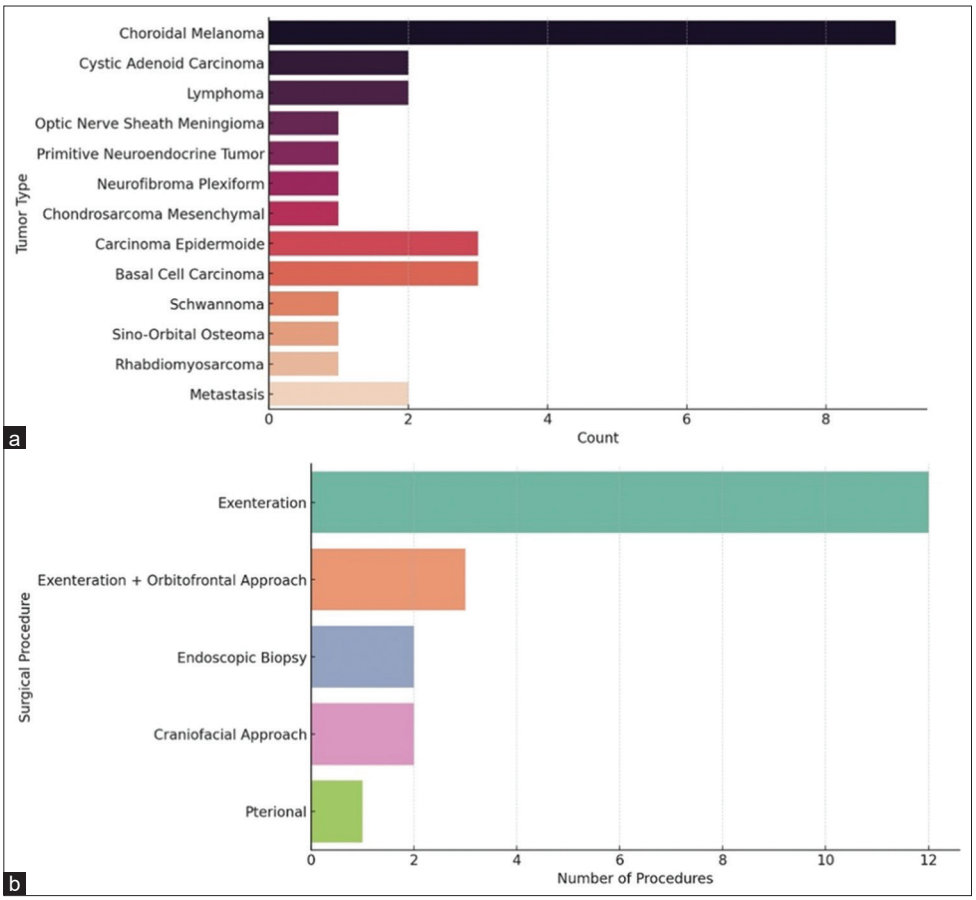

Figure 1: (a) Types of orbital tumors and (b) types of surgical management of the study.

Table 1: Multidisciplinary team for different surgical approaches and medical treatment.

	Surgery (20)	Multidisciplinary team	Exenteration (12)	Exenteration+ orbitofrontal approach (3)	Endoscopic biopsy (2)	Craniofacial approach (2)	Pterional approach (1)	Adjuvant therapy		
								RT (3)	CT (1)	CT+RT (2)
Choroidal melanoma	9	NS, ENT, plast surg, Opht	9	-	-	-	-	-	-	-
Adenoid cystic carcinoma	1	NS, ENT, plast surg, Opht, NO	-	1	-	-	-	-	-	1
Lymphoma	2	NS, Opht, NO	-	-	2	-	-	-	1	-
Optic meningioma	1	NS, Opht, NO	-	-	-	-	1	-	-	-
PNET	1	NS, ENT, Opht, NO	-	-	-	1	-	-	-	1
Plexiform neurofibroma	1	NS, ENT, plast surg, Opht, NO	-	1	-	-	-	-	-	-
Epidermoid carcinoma	2	NS, ENT, plast surg, Opht, NO	2	-	-	-	-	2	-	-
Basal cell carcinoma	2	NS, ENT, plast surg, Opht, NO	1	-	-	1	-	-	-	-
Clear cell renal cell carcinoma	1	NS, ENT, plastic surg, Opht, NO	-	1	-	-	-	1	-	-

PNET: Primitive neuroendocrine tumor, NS: Neurosurgeon, ENT: Head-and-neck surgeon, plast surg: Plastic surgeon, Opht: Ophthalmologist, NO: Neuro-oncologist, CT: Chemotherapy, RT: Radiotherapy

The radiotherapy was performed on three patients with epidermoid carcinoma and one patient with metastasis. Chemotherapy was performed in one case of lymphoma, metastasis (osteosarcoma), and rhabdomyosarcoma. Chemotherapy plus radiotherapy was performed on one patient with adenoid cystic carcinoma and PNET. There were no patients who died in the 30 days following surgery. Complications reported were infection in 2 (6.9%) patients and brain infarction in 1 (3.4%) patient. In most of the patients, complete (82.8%) or subtotal (17.2%) resections were achieved. The follow-up was done from 1 to 9 years. Glasgow Outcome Scale was used, with the following results: 17 (58.6%) patients with GOS grade 5, 9 (31.0%) patients with GOS grade 4, and 3 (10.3%) patients died at the last follow-up. Figure 2 shows Kaplan–Meier cumulative survival (%) with confidence interval in our group of 29 patients in 9 years. There were three patients with residual tumors; two patients were treated with surgery, and one patient with radiotherapy. Table 2 shows all the details.

DISCUSSION

Shinder *et al.*[51] reported 268 orbital lesions, 171 (64%) were primary orbital tumors, 69 (26%) secondary orbital tumors, and 28 (10%) were metastases. Similarly, Ohtsuka *et al.*[38] reviewed 244 orbital tumors, 213 were primary orbital tumors, 23 were secondary tumors, and 8 were metastatic tumors. There are two peaks in the age distribution of the orbital tumors: in children aged 0–9 years and in older aged 60–69 years.[38] In this study, we observed an average age of 53.5 years.

According to the location of the orbital tumor, Darsaut *et al.*[10] divided anatomically into intraconal and extraconal; Ohtsuka *et al.*[38] used extraconal, intraconal, and lacrimal gland area; and Margalit *et al.*[29] classified into intraconal, extraconal, and intracanalicular. We used the intraconal and extraconal classification, because it is the most anatomically representative. Markowski *et al.*[30] reported the most frequent manifestations as follows: proptosis in 100%, limitation of the eyeball movement in 45%, decreased visual acuity in 45%, and pain in 30%. We observed a clinical triad formed by decreased visual acuity, exophthalmos, and pain. The most constant location of the orbital tumor was situated in the lower medial part of the orbital cavity.[41]

Markowski *et al.*[30] divided the site of the tumors into four areas: upper lateral, upper medial, lower lateral, and lower medial on the basis of image studies. Boari *et al.*[8] classified the orbital lesions located in the orbital apex, medial, and superomedial region, which were approached by a fronto-orbito zygomatic craniotomy; a lateral orbitotomy approached tumors situated in the lateral, superolateral, and inferior orbital area.

The best surgical approach is usually decided on the location of the tumor in the orbit in relationship with the optic nerve,

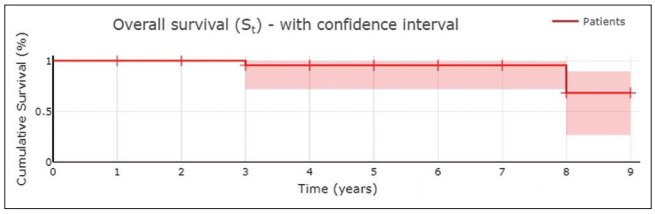

Figure 2: It shows Kaplan–Meier cumulative survival (%) with confidence interval in our group of 29 patients in 9 years.

the size of the lesion, the type of the tumor, and the goal of the surgery (biopsy, total resection, and partial resection). Here, we reported the two main surgical approaches to the orbit, which is to say, the external surgical orbital approach and the endoscopic endonasal transorbital approach.

External surgical approaches

A transcranial approach (pterional and orbitofrontal approach) is suggested when the tumor is located at the orbital apex or to the superior orbital fissure, as it provides the best exposure of the orbital cavity.[52]

The lateral orbital approach was first described by Krönlein,[27] modified by Berke[6] is useful for resection of tumors located lateral to the optic nerve and for lesions located from the superior orbital fissure to the lateral and apical area to the optic nerve.[26] The main neurovascular structures found during this approach are the ophthalmic artery and nasociliary nerve. The abducens nerve runs along the internal side of the lateral rectus muscle. This approach is contraindicated for the resection of tumors of the optic nerve or for tumors that extend into the optic canal.[1,40] The transconjunctival approach implies incision of the conjunctiva inferiorly along the corneal edge. This approach is for small intraconal and extraconal lesions located inferior and medial to the optic nerve. The advantages are the absence of bone removal, the reduction of operating times, the absence of skin incisions and the reduction of morbidity to the orbital elements. The disadvantage is the disinsertion of the lateral rectus muscle, which can sometimes occur.[23] The transciliar approach is eligible for lesions situated superiorly to the optic nerve. In intraconal tumors, since the opening of the optic canal is necessary, the frontal nerve appears beyond the transparent periorbita and the trochlear nerve is located medial to the frontal nerve. The orbital fat is considered an essential element of muscular function.[39] The orbital lymphoma may represent only the first manifestation of a generalized lymphoma.[9] The orbital structure preferred is the lacrimal gland. In this study, the melanoma was the orbital tumor most frequent. Shinder *et al*.[51] in their study with 268 cases reported only two cases with choroidal and conjunctival melanoma. Orbital tumors can be manage with surgery in combination with radiotherapy, or with radiotherapy alone (excellent local control in MALT lymphoma) or with systemic chemotherapy alone.[44] They represent <5–11% of all orbital tumors. We observed only two metastatic lesions in the extraconal space. The survival of the adenoid cystic carcinoma is 15 years in 58% of the patients. Orbital exenteration is usually performed in patients with malignant orbital tumors, with all orbital contents involved by the tumor, with lesions involving the apex or extending beyond the limits of the orbit.[11,16]

Endoscopic endonasal transorbital approach

There are few endoscopic reports on the management of orbital tumors.[28,30,41] The endoscopic can be used alone or combined. The primary use of the endoscope is for lesions located in the middle orbit or orbital apex.[32] In this case there are two main rules in endoscopic management: the first is to avoid crossing the optic nerve and the second is to remove the lamina papyracea below the ethmoidal foramen, reducing the risk of retrobulbar hemorrhage and vision changes. Abuzayed *et al*.[1] described in an anatomic model, the endoscopic endonasal approach to the medial orbital wall. We use the endoscopic endonasal approach to lesions situated at the medial part of the optic nerve, and we also use the endoscopic as a noninvasive approach in biopsy. Other authors use the pterional approach for the biopsy of perioptic lesions.[37] The use of an exoscope in the surgical management of orbital tumors represents a significant advancement in ophthalmologic and neurosurgical procedures. An exoscope is a high-definition digital microscope that provides a magnified, three-dimensional (3D) view of the surgical field.[43] This technology offers several advantages over traditional microscopes and is increasingly being utilized alongside endoscopic techniques for more precise and less invasive surgeries.[46] One of the key benefits of the exoscope is its flexibility in terms of positioning and angle of view. This is particularly advantageous in orbital tumor surgeries where the workspace is confined, and the need for precision is paramount.[5] The exoscope's high-definition and magnified view enhances the surgeon's ability to differentiate between tumor tissue and normal orbital structures, thereby potentially improving surgical outcomes and reducing the risk of complications.[24,33]

Furthermore, the use of an exoscope in orbital tumor surgeries is relatively new and is part of the ongoing evolution of surgical techniques. The incorporation of exoscopic technology into the management of orbital tumors represents a promising development, representing a step forward towards minimally invasive procedures, with the aim of reducing patient recovery times and improving surgical precision. Exoscope improves surgical visualization, allows for greater precision in tumor excision and, when used in conjunction with endoscopic techniques, provides a comprehensive approach to the management of complex cases. Likewise, the use of

Table 2: Comprehensive patient profile and treatment outcomes in orbital tumor surgery.

Patient N°	Age	Sex	Clinical	Location	Tumor	Type	Approach	Extension	Result and complications	Follow-up (years)	GOS
1	22	F	Exophthalmos, decreased visual acuity	Extraconal	Lymphoma MALT	Primary	Endoscopic biopsy.	RT 24 Gy, CT RCHOP 8	Residual	3	5
2	18	F	Exophthalmos, amaurosis	Extraconal	PNET periobit	Secondary	Orbit resection plus subtotal maxillectomy. Reoperated.	RT, CT	No	5	5
3	45	F	SOFS.	Intra and extraconal	Trigeminal V2 Schwannoma	Secondary	Pterional.		Ophthalmoparesis and ptosis	2	5
4	63	M	Exophthalmos. Amaurosis.	Intraconal	Clear cell renal cell carcinoma	Metastasis	Orbito frontal approach + Eye enucleation.	RT 30 Gy	Without tumor	2	4
5	54	F	Exophthalmos	Extra and intraconal	Optic meningioma `	Primary	Pterional; fronto-bitemporal	No	Without tumor. Ophthalmoparesis; Brain infarction medial frontal	2	5
6	42	F	Exophthalmos, ophthalmoparesis, see shadows	Intraconal	Choroidal melanoma	Primary	Eye enucleation	No	Without tumor	7	4
7	61	F	Retroocular pain. SOFS	Extraconal	Adenoid cystic carcinoma	Primary	Fronto zygomatic + enucleation	RT 46 Gy CT, CDDP	Without tumor.	3	5
8	84	F	Ocular pain	Extraconal	Epidermoid carcinoma	Secondary	Eye enucleation	RT 50 Gy 25 sessions	Without tumor	3	4
9	37	M	Ocular pain	Extraconal	Sino-orbital osteoma	Secondary	Biopsy with endoscopic		Residual tumor Without progression	3	5
10	84	F	Blurred vision	Extraconal medial wall.	Basal cell carcinoma in inferior eyelid	Secondary	Local excision	RT in 3 occasions; 45 Gy. Both eyelids	Without tumor.	4	4
11	32	F	Decreased visual acuity.	Extraconal	Basal cell carcinoma in inferior eyelid	Secondary	Eye enucleation	RT 55 Gy	Without tumor	7	5
12	66	M	Ocular pain	Extraconal	Epidermoid carcinoma	Primary	Eye enucleation	RT 30 Gy SNC and 70 Gy orbit	Without tumor in orbit	6	4
13	69	F	Ocular pain	Extraconal	Basal cell carcinoma in inferior eyelid	Secondary	Eye enucleation, craniofacial approach	RT 50 + 16 Gy	Without tumor	6	4
14	64	M	Decreased visual acuity	Extraconal	Squamous cell carcinoma eyelid	Secondary	Eye enucleation	RT, CT	Without tumor, infection	9	5

(*Contd...*)

Table 2: (*Continued*).

Patient N°	Age	Sex	Clinical	Location	Tumor	Type	Approach	Extension	Result and complications	Follow-up (years)	GOS
15	61	F	Decreased visual acuity	-	Choroidal melanoma	Primary	Eye enucleation		Without tumor, infection	3	5
16	81	F	Blurred vision. Decrease of visual acuity.	-	Choroidal melanoma	Primary	Eye enucleation		Without tumor	3	5
17	60	F	Ocular pain	Extraconal	Choroidal melanoma	Primary	Eye enucleation		Without tumor	9	5
18	39	F	Diplopia, scotomas, fotosensibility		Choroidal melanoma	Primary	Eye enucleation	No RT	Without tumor	8	5
19	80	F	Foreign body sensation. Ocular pain.	Extra	Choroidal melanoma	Primary	Eye enucleation.		Without tumor	8	5
20	52	F	Ocular pain, Itching, proptosis	Orbital floor, extraconal	Plexiform neurofibroma	Primary	Orbitofrontal	No RT	Without	7	5
21	53	M	amaurosis	extraconal	Choroidal melanoma	Primary	Eye enucleation	No RT	Without tumor	8	1
22	26	M	Blurred vision	Extraconal	Choroidal melanoma	Primary	Eye enucleation	No RT	Without tumor	8	1
23	88	M	Exophthalmos	Extraconal	Epidermoid carcinoma	Primary and metastasis	No	RT 30 Gy, 10 fx 3 Gy	Residual tumor	2	4
24	47	F	Scotoma decreased visual acuity	Extraconal	Choroidal melanoma	Primary	Eye enucleation	No	Without tumor	1	5
25	54	M	Ptosis, pain, ophthalmoparesis	Extraconal	Adenoid cystic carcinoma		Biopsy, Exenteration, Orbitofrontal	RT 70 Gy 35, 50 Gy		8	5
26	59	F	Blurred vision, ophthalmoparesis, Pain proptosis	Extraconal	Lymphoma MALT	Primary	Endoscopic biopsy		CT	2	4
27	43	M	Proptosis, pain, amaurosis	Extraconal	Osteoblastic osteosarcoma	Metastasis			CT CDDP/ doxorubicin y methotrexate, RT	3	1
28	52	M	Proptosis, blurred vision	Extraconal	Mesenchymal chondrosarcoma	Primary	Orbito frontal zygomatic	RT 46 Gy	Residual tumor	4	5
29	19	M	Proptosis, amaurosis	Extraconal	Rhabdomyosarcoma	Primary		CT	Residual tumor	1	4

GOS: Glasgow outcome scale, M: Male, F: Female, RT: Radiotherapy, PNET: Primitive neuroectodermal tumor, MALT: Mucosa-associated lymphoid tissue, CT: Chemotherapy, CDDP: Cisplatin, RCHOP: Rituximab, cyclophosphamide, doxorubicin, vincristine, prednisolone, No: nothing, SNC: Sinonasal cancer.

augmented reality and telemedicine in the preoperative planning of orbital pathologies has been shown to improve the accuracy and precision of the incision and enable the bioprinting procedure.[14,17,34] In addition, intraoperative imaging enhancement helps guide the orientation of the orbital reconstruction plate and to better identify deep anatomical tissues in real-time.[35,48] As these technologies continue to evolve, it is likely to become a more integral part of orbital tumor surgeries, potentially leading to better patient outcomes and advancements in surgical techniques.[3,15]

The reconstruction of the orbital

The orbital prosthesis can improve the patient's appearance, enable early rehabilitation, shorten surgery and hospitalization time, lower treatment costs, and allow early psychosocial reintegration.[55] The reconstruction of the orbital area, particularly following procedures like orbital exenteration, is a critical aspect of both physical and psychological rehabilitation for patients. This process often involves the use of biocompatible materials such as titanium mesh or methyl methacrylate.[47] The primary objective is to restore the structural integrity of the orbit, which is essential not only to support the eye but also to maintain the correct separation of the orbital contents from adjacent cranial structures. This helps in preserving the function of the eye and maintaining facial esthetics.[21]

The use of an orbital prosthesis offers several advantages. It significantly enhances the patient's appearance and facilitates early rehabilitation. This is crucial in reducing the duration of surgery and hospitalization, which in turn lowers treatment costs.[25] More importantly, it accelerates the patient's psychosocial reintegration, allowing for a quicker return to normal life. Beyond cosmetic improvement, the prosthesis aims to monitor for disease recurrence, ensure the restoration of boundaries between the orbit and neighboring cavities, and achieve an acceptable esthetic outcome.[13,45]

In cases of orbital exenteration, which involves the removal of all orbital contents including the eye, eyelids and surrounding tissues, an orbital prosthesis becomes extremely important.[25] This procedure is often necessitated by extensive tumors or severe trauma, resulting in significant facial deformity and psychological impact. Here, the prosthesis not only restores facial appearance but also significantly improves the patient's quality of life.[19] Technological advancements have greatly improved the effectiveness of orbital prostheses. Customization through 3D printing and sophisticated imaging technologies allow for the creation of highly customized prosthetics that align with the patient's facial contours and skin tone, providing a more natural appearance.[2,53] In addition, recent developments in biomaterials have led to prostheses that are lighter, more durable, and biocompatible, enhancing patient comfort and acceptance.[19] The psychological and functional implications of these prostheses are profound. Esthetically, they play a crucial role in the patient's emotional recovery by mitigating the psychological trauma associated with disfiguring surgeries.[7,20] From a functional standpoint, while esthetics drugs are often the focus, protecting the remaining orbital structures and maintaining facial symmetry are equally crucial. Thus, the reconstruction of the orbital area using these advanced prostheses is not just a cosmetic procedure but a vital component in the comprehensive rehabilitation of patients undergoing significant facial surgeries.[49] In this study we highlighted the role of orbital reconstruction, primarily in orbital exenteration, which is a disfiguring procedure that causes significant deformity. In these cases, we use the orbital prosthesis, as shown in Figure 3.

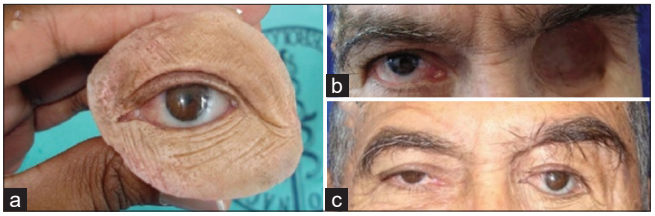

Figure 3: (a) Orbital prosthesis. (b) Patient before cosmetic reconstruction of the orbital area. (c) Patient after cosmetic reconstruction of the orbital area.

Limitations of the study

This study has some limitations, as it reflects the experience of a single institution. The study is based on a limited number of cases, which may not provide a comprehensive representation of the broader patient population with similar conditions. This relatively small sample size limits the generalizability of the findings and may not capture the full spectrum of potential outcomes and complications associated with the surgical technique. Multicenter studies are needed to validate these findings.

CONCLUSION

Our research emphasizes the importance of a multidisciplinary approach, combining the expertise of neurosurgeons, head-and-neck surgeons, plastic surgeons, ophthalmologists, and neuro-oncologists. This collaborative effort enables tailored treatment strategies based on tumor type, location, and relationship with the optic nerve, thereby optimizing patient outcomes. The study's findings highlight the necessity of precise surgical techniques and the pivotal role of advanced technologies such as neuronavigation, endoscopic equipment, and exoscopes in enhancing surgical precision and minimizing invasiveness. The detailed analysis of surgical approaches based on tumor location and characteristics underscores the need for individualized

treatment plans. Furthermore, the successful integration of surgical interventions with radiotherapy and chemotherapy in certain cases demonstrates the potential for multidimensional treatment plans in managing these complex cases.

Ethical Approval

The author(s) declare that they have taken the ethical approval from IRB of Department of Head and Neck, Unidad de Neurociencias, Instituto Nacional de Cancerología, Mexico City, Mexico (06/2023).

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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