

Clinical Article

Surgical Treatment of Orbital Tumors at a Single Institution

Hyun Joon Park, M.D., Seung-Ho Yang, M.D., Il Sup Kim, M.D., Jae Hoon Sung, M.D., Byung Chul Son, M.D., Sang Won Lee, M.D., Ph.D.
Department of Neurosurgery, St. Vincent's Hospital, The Catholic University of Korea College of Medicine, Suwon, Korea

Objective : The authors reviewed the experience of 19 patients with orbital tumors and summarize the clinical features, surgical treatment and outcomes.

Methods : The authors searched the database for all patients who underwent surgery for the treatment of orbital tumors at a single institution between 1999 and 2007. Data from clinical notes, surgical reports, and radiological findings were obtained for the analysis.

Results : Orbital tumors constituted a heterogenous array of histopathology. The presenting symptoms were exophthalmos (52.6%), visual disturbance (26.3%) and pain (21.1%). The surgical approaches used were transcranial in 17 patients. Tumors located in the intraconal or perioptic space were surgically excised using a frontoorbital approach (8 cases), while pterional (3 cases), orbital (2 cases) and combined approaches (6 cases) were used for tumors in other sites. Total resection of tumors was achieved in 12 of 19 patients. In 4 patients with glioma and lymphoma only diagnostic biopsy was done. Three patients experienced visual deterioration postoperatively. Two patients had temporary diplopia, and one patient had temporary ptosis.

Conclusion : Surgical treatment could be the mainstay of therapy for the majority of symptomatic orbital tumors. Many orbital tumors can be treated safely via a transcranial approach. Frontoorbital approach allows the surgeon to reach both the intraorbital and intracranial structures. Knowledge of the microanatomy of the orbit and meticulous surgical skills are necessary to overcome the pitfalls of intraorbital surgery.

KEY WORDS : Orbit · Tumor · Surgery · Approach · Exophthalmos.

INTRODUCTION

Orbital tumors are anatomically divided into three categories : intraconal, extraconal and intracanalicular^{4,10}. This distinction is made on the basis of the relationship between the tumor and muscle cone. The muscle cone is formed by the extraocular rectus muscles and their intermuscular septae, which separate the intraconal space from the extraconal space. Modern diagnostic methods help to determine their location, extent and position relative to the blood vessels, nerves, and muscles in this region. Direct approaches to various parts of the orbit are now possible with the help of these diagnostic advances and the development of surgical techniques. The earlier reports of surgery for orbital lesions involved approaches directed through the lateral wall of the orbit^{13,18}. Since then, various approaches to the

orbit have been developed^{1,5}.

In the present study, we describe the surgical experience of 19 orbital tumors at single institution, with special focus on the importance on surgical approaches of the orbital tumors.

MATERIALS AND METHODS

We searched the database for all patients who underwent surgery for the treatment of orbital tumors at our institution between 1999 and 2007. Data from clinical notes, surgical reports, and radiological findings were obtained for the analysis. Tumor location, size and relation to neighboring anatomical structures were determined using preoperative computed tomography (CT) and magnetic resonance (MR) imaging. A cooperative team of neurosurgeons, an ophthalmologist and plastic surgeons participated in the treatment planning for each patient. All surgeries were performed by a single neurosurgeon. Morbidity, follow-up and outcome were analyzed from entries in the clinical notes. The extent of the tumor resection was determined intraoperatively and confirmed by follow-up MR images taken 3-6 months postoperatively.

• Received : April 25, 2008 • Accepted : August 18, 2008
 • Address for reprints : Sang Won Lee, M.D., Ph.D.
 Department of Neurosurgery, St. Vincent's Hospital, The Catholic University of Korea College of Medicine, 93-6 Ji-dong, Paldal-gu, Suwon 442-723, Korea
 Tel : +82-31-249-7191, Fax : +82-31-245-5208
 E-mail : nslsw@yahoo.co.kr

Different tumor locations, lesion types and the goal of surgery led to different surgical techniques for removal of the tumors. Lateral lesions were treated via transorbital approach, whereas most orbital tumors were managed via transcranial approach. For the biopsy of perioptic lesion, the simple procedure, pterional approach was used. The reconstruction procedure was necessary for the lesions involving the bony structures of orbit and periorbit. The frontoorbital approach was used for the resection of intraconal or perioptic lesions. It included ipsilateral frontal craniotomy and superior orbitotomy depending on the compartments involved by the tumor. A bicoronal scalp incision was made in a suprapariosteal plane after incising the skin above the hairline. A flap was elevated anteriorly beyond the supraorbital ridges and laterally superficial to the fascia of the temporalis muscle. The pericranial flap was elevated up to the periorbit for the procedure of cranialization, and the supraorbital nerves and vessels were carefully separated from the supraorbital notch. The lateral and

medial walls of the involved orbit are exposed. Titanium miniplates were applied to the frontal and supraorbital rim and removed before the osteotomies to facilitate the exact repositioning of the bone segments. After drilling orbital roof out, the periorbit was sharply opened and the tumor was approached. The optic nerve was located medially between the dorsal superior rectus and levator muscles and medial rectus muscle. When working medial to the optic nerve, great care should be taken to avoid injury to the central retinal artery and ciliary nerve. Dissection in the posterior medial portion of the orbit could interfere with retinal venous drainage. Small feeders were coagulated to separate the tumor from the muscle and neural structures in the periorbital fat for the total resection of intraconal lesions. The reconstruction of orbital roof was not performed.

RESULTS

A total of 19 patients who underwent surgery for the

Table 1. Clinical data of the patients with orbital tumors

No	Age	Sex	Presenting symptom	Location	Diagnosis	Approach	Extent	Complication	F/U (mon)	Outcome
1	34	F	Exophthalmos	Intra-, extraconal	Sarcoma	TCA+ transzygomatic	Total	-	14	Good
2	19	M	Palpable Mass	Supraorbital	Sarcoma	TCA+ reconstruction	Subtotal	-	15	Recurrence
3	40	M	Exophthalmos	Lateral wall of orbit	Sarcoma	TCA+ reconstruction	Subtotal	-	13	Expire
4	63	M	Exophthalmos	Intra-, extraconal	Sarcoma	TCA+ reconstruction	Subtotal	-	9	Loss
5	22	M	Decreased visual acuity	Intraconal, apex	Glioma	FOA	Biopsy	-	18	Loss
6	29	M	Exophthalmos	Intra-, extraconal	Glioma	PTA	Biopsy	-	11	Loss
7	54	F	Decreased visual acuity	Intraconal	Schwannoma	FOA	Total	-	27	Good
8	47	M	Exophthalmos	Intraconal	Schwannoma	FOA	Total	Temporary diplopia	60	Good
9	85	M	Exophthalmos	Intra-, extraconal	lymphoma	FOA	Biopsy	-	22	Recurrence
10	48	F	Exophthalmos	Extraconal	Lymphoma	PTA	Biopsy	Ptosis, Vision aggravation	37	Poor
11	49	M	Palpable Mass, Pain	Extraconal	Mucocele	TCA+ reconstruction	Total	-	22	Good
12	72	F	Headache	Extraconal	Mucocele	TCA+ reconstruction	Total	-	34	Good
13	42	F	Decreased visual acuity	Intraconal	Cavernous Hemangioma	FOA	Total	Enophthalmos	8	Good
14	57	M	Exophthalmos	Intraconal medial	Cavernous Hemangioma	FOA	Total	Temporary diplopia	5	Good
15	66	F	Exophthalmos, pain	Extraconal	Meningioma	PTA	Total	Vision aggravation	12	Poor
16	18	F	Palpable Mass	Intraconal lateral	Teratoma	LO	Total	-	14	Good
17	65	F	Decreased visual acuity	Intraconal, apex	Fibroangioma	FOA	Total	Vision aggravation	29	Fair
18	50	M	Exophthalmos, pain	Intra-, extraconal	Neuroendocrine carcinoma	FOA	Total	-	10	Expire
19	77	M	Decreased visual acuity	Intraconal lateral	Squamous cell carcinoma	LO	Total	-	18	Good

TCA : transcranial approach, FOA : frontoorbital approach, PTA : pterional approach, LO : lateral orbital approach

treatment of orbital tumors were enrolled in the present study. There were 11 males and 8 females, and their ages ranged from 18 to 85 years (mean age of 49.3 years). Exophthalmos (52.6%), visual disturbance (26.3%) and pain (21.1%) were major symptomatic presentations. The underlying pathologies included 4 metastases, 2 gliomas, 2 schwannomas, 2 lymphomas, 2 mucoceles, 2 cavernous hemangiomas, 1 meningioma, 1 teratoma, 1 fibroangioma, 1 neuroendocrine carcinoma, and 1 squamous cell carcinoma. Primary bone tumors involving the orbit, such as osteoma and fibrodysplasia, were excluded. The primary foci of the 4 metastases were sarcoma of the skeletal bone in 3 cases and unknown in 1. The median follow-up duration was 15 months (range 5-60 months). The summary of 19 orbital tumors was described in Table 1.

The surgical approaches used were transcranial in 17 patients and orbital in 2. Intraconal and extraconal lesions were treated via the transcranial approach. The lateral orbital approach was performed in two cases with lesions located in lateral intraconal region (one patient with teratoma and one with squamous cell carcinoma). The frontoorbital approach was used for the treatment of intraconal or perioptic lesions.

The aim of treatment of orbital metastases and mucoceles was to relieve the pain and restore the cosmesis. The combined approach using transcranial and reconstruction

was tailored for each case.

Total, subtotal resection and biopsy were achieved in 12, 3 and 4 patients, respectively. The lesions treated with biopsy were gliomas and lymphomas. Visual function was good in most patients. Two patients with meningioma (pterional approach) and fibroangioma (frontoorbital approach) experienced visual deterioration postoperatively. It was caused by the excessive coagulation of plexus during dissection of the tumor. Visual function deterioration and ptosis occurred in one patient with lymphoma (pterional approach). The manipulation and retraction of the orbital structures was time-consuming because the identification of the tumor was difficult from periorbital fat. Two patients with schwannoma and cavernous hemangioma (frontoorbital approach) had temporary diplopia. One patient with a large cavernous hemangioma had enophthalmos after the removal of the orbital mass. None of the patients died as a result of the surgical procedures.

Illustrative Cases

Case 1

A 41-year-old woman was referred for the assessment of blurred vision in the left eye. Visual acuity assessed by a picture chart was 1.0 in the right eye and 0.4 in the left eye. Slit-lamp examination was within normal limits in both

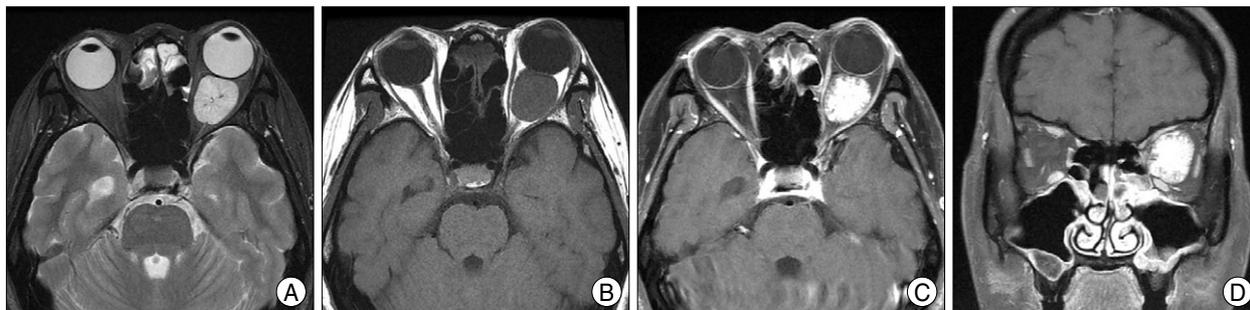


Fig. 1. Preoperative magnetic resonance images revealing a round and well-enhanced mass after gadolinium injection, occupying the entire intraconal region. It displaces the optic nerve laterally and indents the globe. A : T2-weighted axial. B : T1-weighted axial image. C : T1-weighted and enhanced axial image. D : T1-weighted and enhanced coronal image.

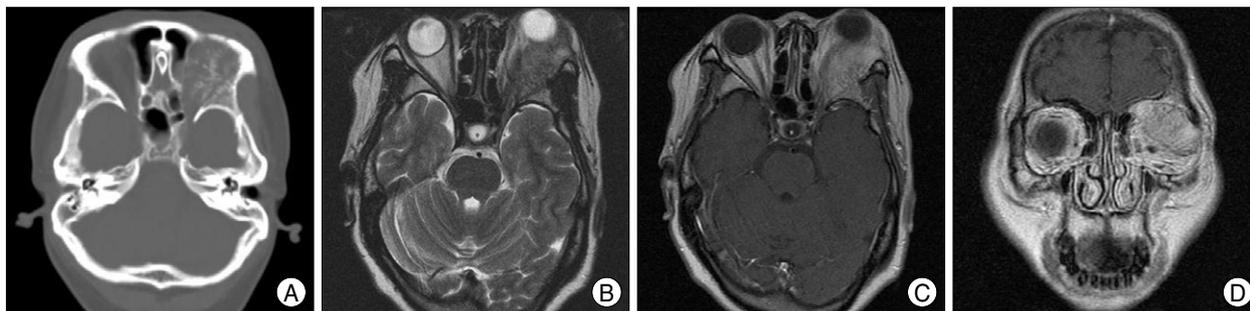


Fig. 2. Preoperative computed tomography images (A) demonstrating an orbital lesion destroying orbit wall and sphenoid bone. Preoperative magnetic resonance images showing a poorly demarcated and enhanced mass in the left ocular and paraocular space (B : T2-weighted axial, C : T1-weighted and enhanced axial image, D : T1-weighted and enhanced coronal image).

eyes. Dilated fundus examination showed papilledema in the left eye. Brain MRI showed a well-encapsulated mass in the left ocular space. The lesion measured $21 \times 19 \times 24$ mm. It displaced the optic nerve laterally and indented the globe (Fig. 1). The patient underwent tumor excision using a frontoorbital approach, and tumor was completely removed. The histopathology report confirmed the lesion to be a cavernous hemangioma. Ptosis was noted postoperatively, but it resolved 3 months later.

Case 2

A 35-year-old woman was referred for the assessment of exophthalmos in the left eye. Chemotherapy had been administered for the treatment of sarcoma in the pelvic bone following orthopedic surgery. Preoperative radiological images showed an orbital lesion involving the bony structures of the orbital wall and sphenoid region (Fig. 2). The lesion measured approximately $40 \times 42 \times 48$ mm. The frontoorbital approach was modified according to tumor extension. The sphenoid ridge and zygoma were severely destroyed by the tumor invasion. After total resection of the lesion, the zygoma was reconstructed with bone resin for cosmetic purposes. Histopathology revealed metastatic sarcoma. The postoperative course was uneventful.

DISCUSSION

There are 2 major types of surgical approaches used for the removal of orbital tumors: transorbital approaches and extraorbital or transcranial approaches^{2,15}. While anterior lesions are treated via transorbital approaches, lesions of the posterior third of the orbit and periorbit can be treated via an extraorbital approach^{3,12}. When surgeons select surgical approaches, in addition to the location of the tumor, other factors, such as the size of the lesion, goal of the surgery (biopsy, debulking, or gross-total excision), and the characteristics of the tumor, must be considered.

The transcranial approach in which the orbital rim is preserved was initially developed by Dandy¹⁷ and has been subsequently modified^{11,14}. The transcranial approach with orbital osteotomy was initially described by Frazier⁶ in 1913, and it has since been modified several times⁸. The subcranial approach can also be useful in treating midline lesions involving the orbit, anterior skull base, and paranasal sinuses. We prefer the two-piece transcranial approach, which includes unilateral frontal craniotomy followed by orbitotomy. This approach facilitates the visualization of intraorbital lesions through the lateral wall of the orbit and its roof. The two-piece transcranial approach can be used to remove large intraocular masses, such as cavernous angiomas

and schwannomas. This approach is suitable for lesions in the orbital apex and the superior orbital fissure, such as glioma, meningioma and lymphoma. But, it is difficult to approach the medial side of the orbit via a transcranial approach due to the narrow surgical corridor and the risk of ciliary nerve injury. Periorbital lesions mainly involving bony structures of the orbit, such as metastases and mucocele, require a tailored approach, meaning that different approaches are combined on a case-by-case basis. The combined approach with reconstruction is useful for solving the cosmetic problems of each case.

Visual complications occurred in 6 patients in our series. Transient diplopia was noted in 2 patients, due to edema of the globe, not from neural and muscular damage. Postoperative diplopia and ptosis had resolved within 3 months after the operation. Visual deterioration was noted in 3 patients with meningioma, lymphoma and fibroangioma. The intraorbital portion of the optic nerve derives most of its blood supply from the plexus in the pia mater, which is primarily supplied by the ciliary arteries⁹. In our cases, it is speculated that tumor manipulation using bipolar coagulation and retractors compromised the blood supply to the optic nerve and venous drainage, even though the lesion was easily visualized using the routine transcranial approach. We recently used frameless image-guided neuronavigation for orbital tumor surgery. It clearly reduces the operative risk and increases the effectiveness of microsurgical orbital procedures⁷. Moreover, the surgical targets in the orbit are fixed structures, thus no shifting occurs and continuous high intraoperative navigation accuracy can be achieved¹⁶. Tarsorrhaphy is very useful in preventing postoperative enophthalmos. We usually stitch out the tarsorrhaphy 3 days after the operation.

Although definitive surgical treatment remains the mainstay of therapy for the majority of symptomatic orbital tumors¹³, extensive lesions involving the medial part of the orbit and anterior skull base are still challenging. These lesions should be approached by a multidisciplinary team that includes a head and neck surgeon and a plastic surgeon. Detailed knowledge of the microanatomy of the orbit is necessary and would allow surgeons to overcome the pitfalls of intraorbital surgery.

CONCLUSION

Orbital tumors can be treated safely using transcranial approaches. However, the treatment of complex and extensive lesions needs to be modified for each patient according to the goal of surgery, and it should be carried out by a multidisciplinary team.

References

1. Al-Mefty O, Fox JL : Supralateral orbital exposure and reconstruction. *Surg Neurol* 23 : 609-613, 1985
2. Badie B : *Neurosurgical Operative Atlas*, ed 2. New York : Thieme, 2007, pp270-288
3. Bejjani GK, Cockerham KP, Kennerdel JS, Maroon JC : A reappraisal of surgery for orbital tumors. Part I : extracranial approaches. *Neurosurg Focus* 10 : E2, 2001
4. Darsaut TE, Lanzino G, Lopes MB, Newman S : An introductory overview of orbital tumors. *Neurosurg Focus* 10 : E1, 2001
5. Delfini R, Raco A, Artico M, Salvati M, Ciappetta P : A two-step supraorbital approach to lesions of the orbital apex: technical note. *J Neurosurg* 77 : 959-961, 1992
6. Frazier CH : An approach to the hypophysis through the anterior cranial fossa. *Ann Surg* 57 : 145-150, 1913
7. Hejazi N : Frameless image-guided neuronavigation in orbital surgery : practical applications. *Neurosurg Rev* 29 : 118-122, 2006
8. Jane JA, Park TS, Pobereskin LH, Winn HR, Butler AB : The supra-orbital approach : technical note. *Neurosurgery* 11 : 537-542, 1982
9. Kang JK, Lee IW, Jeun SS, Choi YK, Jung CK, Yang JH, et al : Tumors of the orbit : pitfalls of the surgical approach in 37 children with orbital tumor. *Childs Nerv Syst* 13 : 536-541, 1997
10. Kennerdell JS, Maroon JC, Malton ML : Surgical approaches to orbital tumors. *Clin Plast Surg* 15 : 273-282, 1988
11. MacCarty CS, Brown DN : Orbital tumors in children. *Clin Neurosurg* 11 : 76-93, 1964
12. Margalit N, Ezer H, Fliss DM, Naftaliev E, Nosek E, Kesler A : Orbital tumors treated using transcranial approaches: surgical technique and neuroophthalmological results in 41 patients. *Neurosurg Focus* 23 : E11, 2007
13. Maroon JC, Kennerdell JS : Surgical approaches to the orbit : indications and technique. *J Neurosurg* 60 : 1226-1235, 1984
14. Schmidek HH, Sweet WH : *Operative Neurosurgical Techniques : Indication, Methods, and Results*, ed 4. Philadelphia : WB Saunders Co., 2000, pp198-262
15. Raimondi AJ : *Pediatric Neurosurgery*, ed 2. New York : Springer-Verlag, 1998, pp194-205
16. Reinges MH, Nguyen HH, Krings T, Hutter BO, Rohde V, Gilsbach JM : Course of brain shift during microsurgical resection of supratentorial cerebral lesions : limits of conventional neuronavigation. *Acta Neurochir (Wien)* 146 : 369-377; discussion 377, 2004
17. Youmans JR : *Neurological Surgery*, ed 5. Philadelphia : WB Saunders Co., 2004, pp1317-1381
18. Wilson WB, Gordon M, Lehman RA : Meningiomas confined to the optic canal and foramina. *Surg Neurol* 12 : 21-28, 1979