Combined Surgical Approaches In and Around the Orbit

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Abstract

Orbital pathology requiring surgery can be planned based on the nature of the disease and the position of this relative to the globe and optic nerve complex. Multidisciplinary treatment is now common, and this sometimes includes multiple surgical corridors employed for approach. The orbit is also now frequently used as a corridor to intracranial pathology, and these same processes may be applied. Combined surgical approaches, whether at the same time or staged, allow for minimization of manipulation of critical neurovascular structures in complex skull base pathology.

Keywords

- orbit
- abscess
- tumor
- meningioma
- cavernous hemangioma
- endoscopic
- optic nerve

Introduction

When considering orbital pathology requiring surgery, the approach is dictated by the position of the abnormality in relation to two things: the eye itself and the critical neurovascular structures, most important of which is the optic nerve/ophthalmic artery complex. The ophthalmic artery is less critical than its most important end artery, the central retinal artery, which arises within the dural sheath of the nerve ~1 cm posterior to the back of the globe.

The recent tidal shift in medicine toward multidisciplinary care has been quite positive for orbital surgery. Disease in the posterior orbit, an area formerly fraught with morbidity for the patient, can much more easily be addressed by a team of surgeons. Masses that cross anatomic boundaries can be treated as a single entity, rather than incompletely by one specialty or another. Comanagement is nearly always in the patient's best interest and fosters the expansion of our learning as surgeons. This article will address combined approaches (meaning use of more than one surgical corridors) for pathology in or near the orbit.

Typical Pathologies

The most common symptom/sign of orbital pathology is proptosis (protrusion of the eye). This is most commonly caused in adults by thyroid eye disease and in children by infection or other inflammation.[1,2] Even these most common of orbital pathologies will sometimes benefit from a combined approach. The anatomic space(s) affected by pathology will dictate surgical approach (and, in this discussion, whether one corridor will be sufficient) with at least as much influence as the type of pathology. For example, a medial orbital abscess in a child is almost always associated with sinusitis; if surgery is required, at the very least, sinusotomy will be needed, often with associated anterior approach for abscess drainage, especially in cases where the vision is imminently compromised. Another example is a juvenile nasal angiofibroma, which arises from the internal maxillary artery and primarily involves the nasal cavity but may also grow into the orbit and intracranial space, requiring multiple surgical corridors to preserve neurovascular structures such as the optic nerve and carotid artery. Thyroid eye disease, when requiring orbital decompression, is often best approached with a balanced decompression, opening both the medial and lateral walls of the orbit for maximal relief of proptosis, and, if present, compressive optic neuropathy.[3] Another case in which to consider a combined approach is the setting of sinus or skin malignancy secondarily involving the orbit.

Any orbital pathology located anterior to the equator of the eye, and confined to the orbit and/or lids, may be excised directly. Likewise, lacrimal gland pathology and extra- and intraconal diseases located primarily lateral to the optic

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Pearls and Tips

- Pathology located mainly anterior to the equator of the globe, and confined to the orbit, does not require a combined approach.
- Disease in the posterior orbit is more easily and safely addressed with a team of surgeons, choosing either a single approach or multiple corridors.
- Orbital disease primarily lateral to the optic nerve is best approached with a traditional lateral orbitotomy (not a combined approach).
- Abscesses in the subperiosteal space often require combined approaches, including endoscopic sinusotomy and external decompression.
- Processes that involve orbit and adjacent soft tissue are usually best approached with a combination of ear, nose, and throat (ENT), ophthalmology, and, sometimes, general plastic surgery.
- When treating abnormalities that involve the orbit and the intracranial space, a combination of ophthalmology, neurosurgery, and ENT may be used to minimize manipulation of neurovascular structures.
- It is critical always to protect the cornea from desiccation during surgery, either by temporary tarsorrhaphy when the palpebral fissure is not needed for access or by contact lens lubricated with ointment when using the interpalpebral space.

nerve may be addressed with a lateral orbitotomy and reconstruction. These are workhorse approaches that every orbital surgeon learns early in her or his career.

On the other end of the spectrum are those types of surgical pathology that refuse to obey the dicta set forth in textbook chapters: they arise medial to the optic nerve posterior to the globe, extend from the orbit via some fissure to the intracranial space, or grow into the orbit from the brain, the bone, the skin, or the sinuses.

The most common orbital masses referred to a large academic center included dermoid cysts, lymphomas, and cavernous hemangiomas.[4] Approximately 30% of orbital masses proved to be malignant in this series; roughly one-third of these was secondary and two-thirds were primary. About 8% of those lesions were meningiomas, ~9% were cavernous hemangiomas, and at least 13% were lymphoproliferative. While the latter requires only biopsy, more definitive surgery is frequently desirable for other masses in this group.

Determination of Need for Combined Surgical Approaches

Intraorbital

If the pathology is located anterior to the equator of the globe, traditional anterior orbitotomy procedures suffice. These can be transconjunctival or via the lid crease.

Disease located posterior to the equator of the globe (deeper in the orbit) is more difficult to reach safely. The major neurovascular structure is the optic nerve/ophthalmic artery complex, and position relative to this will determine what approach is appropriate (►**Fig. 1**). Approaching the extra- or intraconal space lateral to the optic nerve does not require a combined approach; a traditional lateral orbitotomy will give good visibility back to the orbital apex. Working in the posterior orbit superior to the optic nerve is familiar for many neurosurgeons; this has been approached with a pterional craniotomy in the past. Our group more frequently uses an eyebrow or eyelid crease incision and smaller craniotomy for access to lesions superior to the optic nerve. Deep pathology medial and/or inferior to the optic nerve is most commonly handled now via endoscopic endonasal approach (EEA), with or without the addition of transconjunctival assistance for control of anterior extension of the mass or extraocular muscles. This has become preferred to previous methods of performing lateral orbitotomy to allow for displacement of orbital contents, then approaching either by Lynch or transconjunctival incisions. A very useful grading system for cavernous hemangioma, CHEER (Cavernous Hemangioma Exclusively Endonasal Resection), has recently defined the position of the tumor in relation to the optic nerve and the main inferior trunk of the oculomotor nerve.[5] A useful concept for consideration of surgical approach is that which places the right optic nerve at the center of a clock face, and then has overlapping zones ascribed to each position relative to this.[6]

Often, sinonasal pathology will extend into the orbit. Rather than orbital exenteration, a combination of endoscopic and external approaches will be used to eradicate tumor (e.g., esthesioneuroblastoma that affects the lacrimal duct and sac). Working via external and internal corridors simultaneously can allow for excellent visualization and less trauma to surrounding tissue.

A specific note about orbital abscesses frequently encountered in both pediatric and adult age groups: the overwhelmingly most common cause of orbital abscess is infectious sinus disease. This often requires functional endoscopic sinus surgery, which, in some cases, can address medial or inferior subperiosteal abscesses. In dire cases (those with optic neuropathy or impending corneal perforation), often external or transconjunctival decompression/drainage of the orbital abscess component is prudent because it can be done very quickly. Approaching the subperiosteal space via the sinus, while elegant, is less efficient and reliable.

Intracranial

At the central skull base, where operating via the orbit may prove useful, if we again place the most important neurovascular structure, the optic nerve/carotid complex, at the center of the picture, and work from the premise of minimizing its manipulation, we can similarly tailor our approach by combining several surgical corridors in the same patient (►**Fig. 2**).

Pathology medial and/or inferior to the medial optocarotid recess may easily be reached via EEA. When tumor extends superiorly approximately pass the midpoint of the orbital roof,

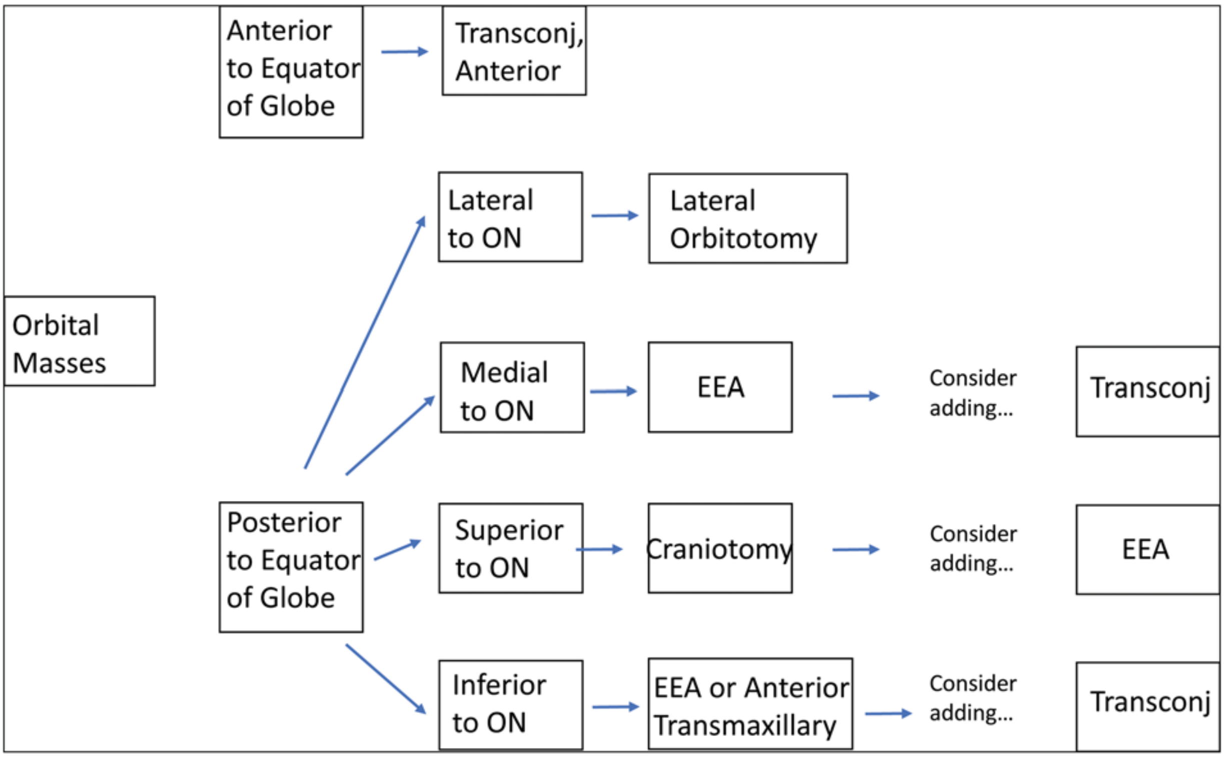

Fig. 1 Schematic for choosing surgical approach(es) for intraorbital pathology. EEA, endoscopic endonasal approach; ON, optic nerve; Transconj, transconjunctival.

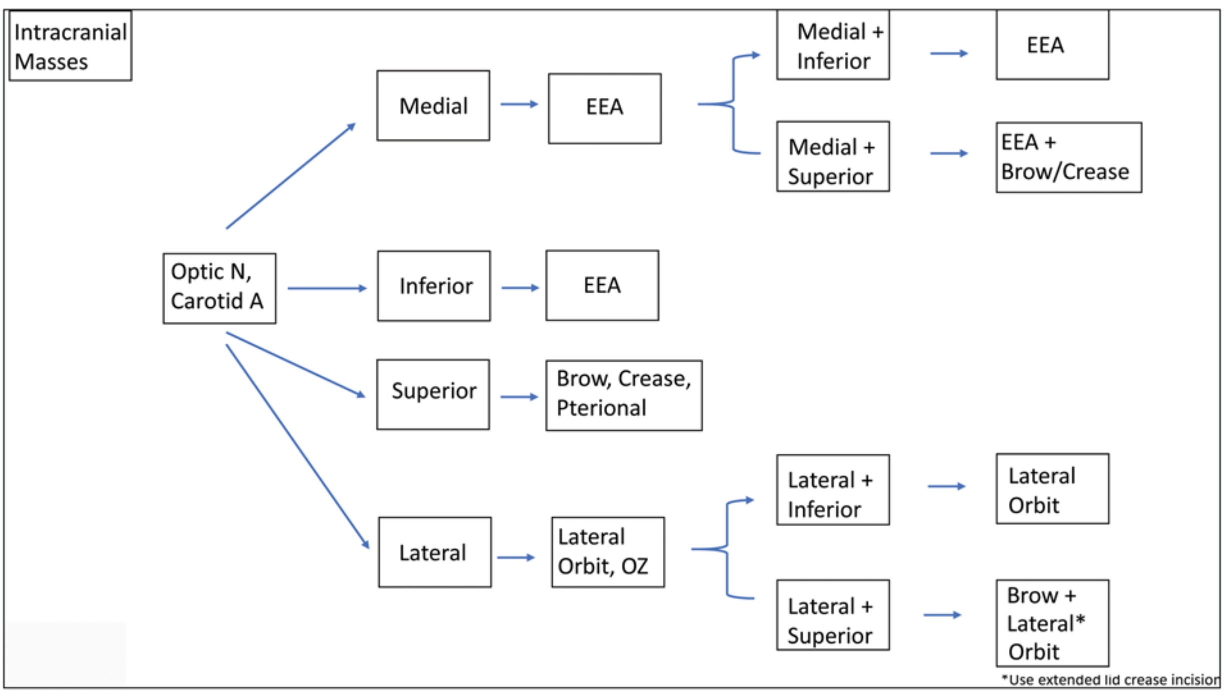

Fig. 2 Schematic for choosing surgical approach(es) for intracranial pathology. The relationship of the pathology relative to the key neurovascular structures (optic nerve [N], carotid artery [A]) largely determines approach selection. EEA, endoscopic endonasal approach; I, inferior; L, lateral; M, medial; OZ, orbitozygomatic; S, superior.

it becomes necessary to add a supraorbital craniotomy, usually via the eyebrow. Similarly, disease primarily superior to the optic nerve/carotid complex, which may include vascular pathology such as aneurysm or compression, would be addressed via an eyebrow, lid crease, or pterional craniotomy. With extension medially such as to the olfactory groove, addition of an EEA is helpful. Unilateral transcranial approaches provide limited access to the anterior olfactory sulcus. If more lateral access is needed, for instance, in a patient with a large sphenoid wing meningioma with compression of the optic canal, both lateral orbitotomy and supraorbital exposure can be combined through an extended lid crease incision.

As a lateral orbit exposure can reach the floor of the middle fossa, this can also be considered for masses that extend from the infratemporal fossa intracranial, when combined with an EEA or Caldwell–Luc for inferior control. The lateral orbitotomy would also be appropriate combined with more posterior approaches for pathology that lies lateral to the cavernous sinus and extends posteriorly (e.g., schwannoma or meningioma).

It is important when operating in and around the orbit, particularly when multiple surgeons/teams are working, to protect the cornea from drying. When the palpebral fissure is not needed for access, the lids may be sutured together for the duration of the case. When the palpebral fissure is part of the incision (with a lateral approach), a plastic corneal protector should be lubricated with eye ointment and sutured to both lids with the suture hole placed either medially or laterally, depending on which area is needed.

Intraoperative Neurophysiology

For any transcranial approach, standard SSEP monitoring is used. For operations involving only the orbit, no neurophysiologic monitoring is appropriate. Monitoring of the size and reactivity of the pupil periodically during the case is advisable. Occasionally, for approaches which impact the superior orbital fissure or cavernous sinus, nonsterile leads can be placed in the orbit adjacent to the extraocular muscles if the anterior orbit is not exposed in the surgical field. If the orbit is included in the sterile field, then either sterile leads can be placed or simply observation of muscle activation can be used with a stimulating probe to help localize the oculomotor nerves.

Reconstruction

Reconstruction of the orbit must address both bony anatomy and soft tissue closure. The Bony orbital rim is nearly always reconstructed with ultralow profile miniplates in precise anatomic alignment. One exception to this is where thyroid orbitopathy or tumor has caused massive proptosis; it may be better, in this case, to avoid replacing the lateral orbital rim. Due to the bulky temporalis muscle in that area, a cosmetic defect is almost never apparent.

The orbital walls themselves need not be reconstructed if periorbita has remained largely intact. Pulsatile exophthalmos from a large orbital roof defect will almost always resolve over weeks to months if the intracranial pressure remains normal. If periorbita has been significantly violated, often a sheet of pericardium or porcine intestinal matrix can be tacked over the orbital contents to the periorbital remnants with 6.0 absorbable suture. This is particularly useful when separating the superior orbit from dura. The medial orbit is generally covered with a free mucosal graft during endoscopic endonasal surgery and heals well. The orbital floor can be reconstructed with a variety of materials, from nylon sheet to barrier-covered titanium plates to custom polymer plates. One caveat is to make sure that orbital tissue is separated from bare titanium because firm scarring to the titanium will occur and has a high risk of causing restrictive strabismus.

Complications

Complications of combined approaches to the orbit mirror those of all orbital surgery: damage to vision, strabismus (either paralytic or, more commonly, restrictive), and suboptimal cosmesis (from the position of the eye or one or both lids). Damage to vision comes either from direct trauma to the optic nerve or from edema or hemorrhage postoperatively. The patient should be kept inpatient for at least overnight, as most orbital hemorrhage will occur in the first 24 hours after surgery, and can be addressed immediately by lateral canthotomy, osmotic agents, or urgent reoperation.

Strabismus is avoided by gentle handling of the orbital contents and by using careful reconstructive techniques that avoid incarcerating any orbital tissue, as well as materials that are smooth and nonreactive (i.e., not bare titanium). Much early strabismus is due to edema causing the eye to be in a slightly different position than preoperative and will resolve over days to weeks. Paralytic strabismus will also often resolve over months, and it is important to wait before performing strabismus surgery on these patients.

Suboptimal cosmesis due to abnormal position of the eye can be minimized by reconstruction of orbital rims in a precise manner, and careful consideration of the need for reconstitution of the orbital walls, either by flexible or by rigid materials. When it is anticipated that the missing area of support will be large, preoperative preparation of a custom implant may give the best result. Precise layered reapproximation of the soft tissue of the lids and surrounding areas will usually lead to an aesthetic result. When the eye is swollen closed for any period of time, or when the posterior portion of the roof is removed (in the area of the origin of the levator palpebrae superioris muscle), weeks to months of observation will usually see the resolution of resultant ptosis (at least 6 months in the latter case).

Case 1: EEA + Eyebrow Craniotomy

A 49-year-old healthy man complained of headaches after motor vehicle accident was found to have a left anterior clinoid meningioma on computed tomography (►**Fig. 3**). His vision was not affected clinically, but some thinning of his ganglion cell layer on optical coherence tomography was found, so he was offered EEA and left eyebrow craniotomy in the same operation to achieve a Simpson Grade I resection. As the tumor dipped into the olfactory groove and involved the bone of the planum, radical resection and reconstruction were challenging or impossible via a purely eyebrow approach, and as it extended lateral to the midportion of the orbit and arose from the anterior clinoid, EEA alone would not be sufficient. During EEA, a nasal septal flap was raised and used to reconstruct the skull base primarily. He suffered

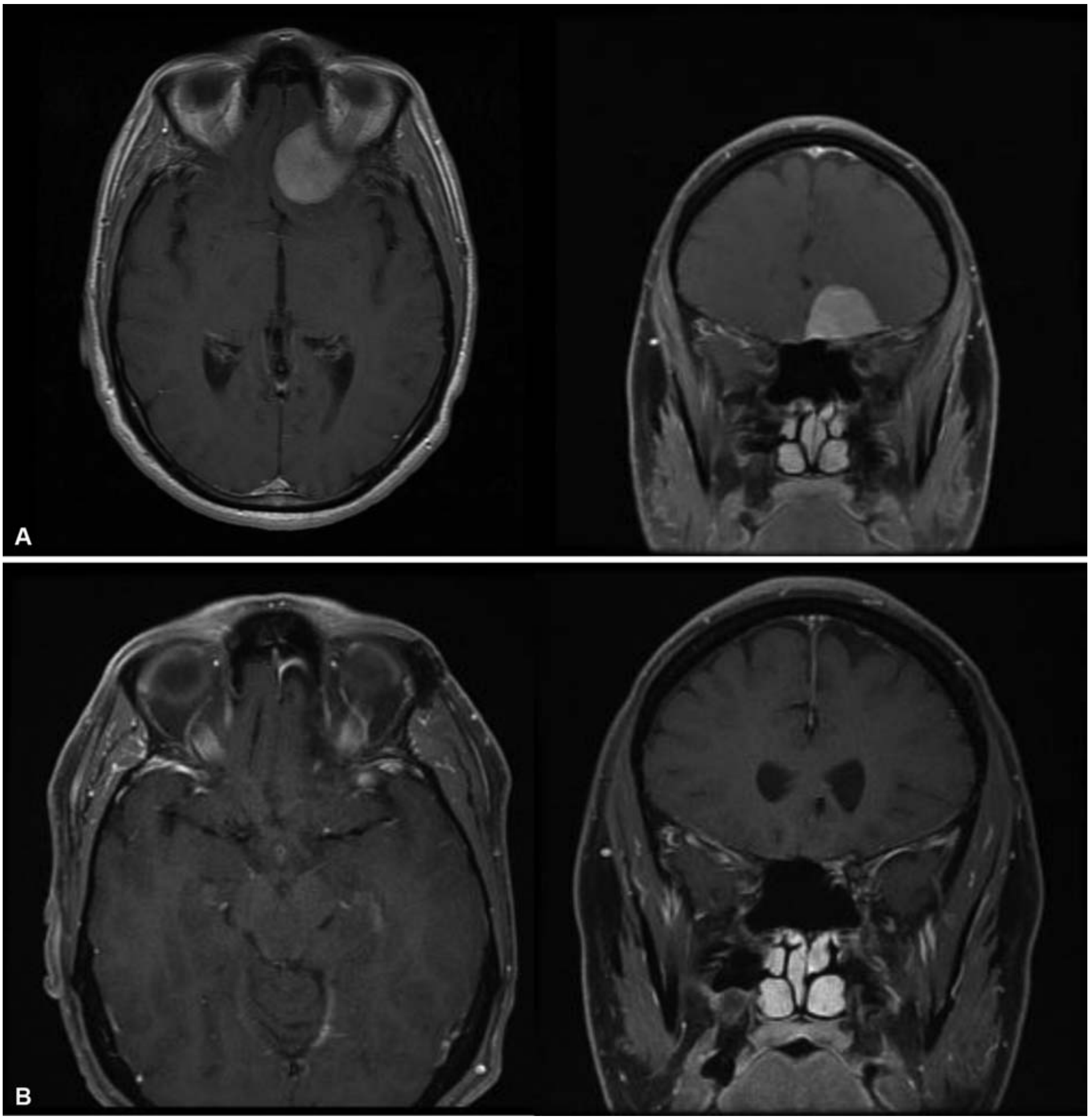

Fig. 3 (A) Preoperative-enhanced axial and coronal T1 MRI of anterior clinoid/planum meningioma (Case 1). (B) Enhanced axial and coronal T1 MRI 3-year postoperative scan. MRI, magnetic resonance imaging.

no complications and postoperative scans showed no recurrence.

Case 2: EEA + Caldwell–Luc + Lateral Orbit

A 25-year-old healthy man who reported only mild left facial paresthesias was found to have a juvenile nasal angiofibroma, proven by prior attempt at resection. The initial surgery elsewhere was discontinued due to excessive blood loss. The patient presented for definitive resection of the mass centered in the left pterygopalatine fissure and extending intracranially and into the left infratemporal fossa and orbital apex (►**Fig. 4**). His only neurologic deficits were the paresthesias and a very mild left optic neuropathy. Because of the encasement of the left carotid artery and orbital apex, the mass was approached via a combined EEA, a Caldwell–Luc anterior maxillary antrostomy, and a lateral orbitotomy. The tumor was able to be controlled and dissected via multiple corridors and was successfully removed en bloc without immediate or late complications.

Case 3: EEA + Transconjunctival

A 31-year-old woman presented with decreased vision and increasing proptosis on the left. She was known to have an orbital cavernous hemangioma and had undergone medial orbital decompression several years previously with relief of her symptoms of pressure sensation and scotoma. She now has a dense left optic neuropathy and central scotoma. The cavernoma had enlarged (►**Fig. 5**). She was operated using a combined endonasal and transconjunctival approaches, the latter necessary for control of the anterior portion of the mass and orbital floor reconstruction. She had excellent

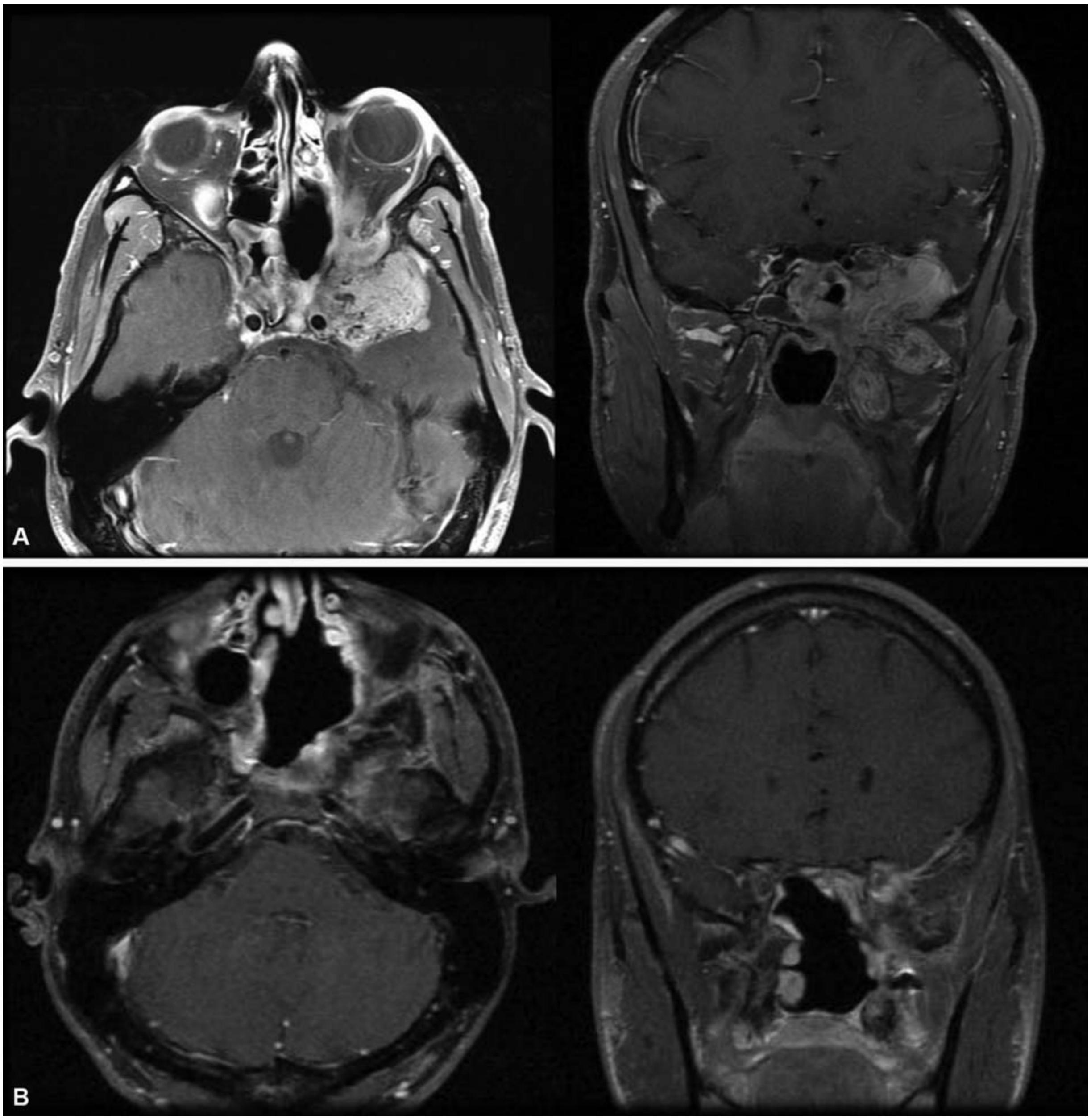

Fig. 4 (**A**) Preoperative-enhanced T1 MRI of juvenile nasal angiofibroma residual after partial resection (Case 2). (**B**) A 6-month postoperative scan. MRI, magnetic resonance imaging.

return of vision in the eye but had a partial third nerve palsy postoperatively with dilation of the pupil. This was thought to be due to the manipulation of the inferior oblique muscle with resultant traction on the associated parasympathetic fibers to the pupillary sphincter during surgery. She also later required removal of the orbital floor alloplast due to infection. The eye movement abnormalities were resolved with observation.

Case 4: EEA + External Eyelid Crease

A 19-year-old woman noted tearing of her right eye and nasal obstruction for ~1 year. She presented with a palpable mass in her right lacrimal sac, hypoesthesia of V2, and nasal tumor obstructing her right nasal cavity. This was biopsied and found to be esthesioneuroblastoma (►**Fig. 6**). Surgical resection was planned to spare the orbit, and EEA and external dacryocystectomy with orbital exploration and removal of orbital roof and periorbita were performed. She then underwent two cycles of chemotherapy and a course of proton-beam irradiation, after which, scans were reported as no evidence of locoregional disease. She had no enophthalmos, expected epiphora, and mild diplopia which were clinically insignificant.

Conclusion

Operating in the posterior orbit is often best done safely and expeditiously by a team of surgeons, sometimes using several approaches to one pathology. The position of surgical pathology relative to the main neurovascular structure of

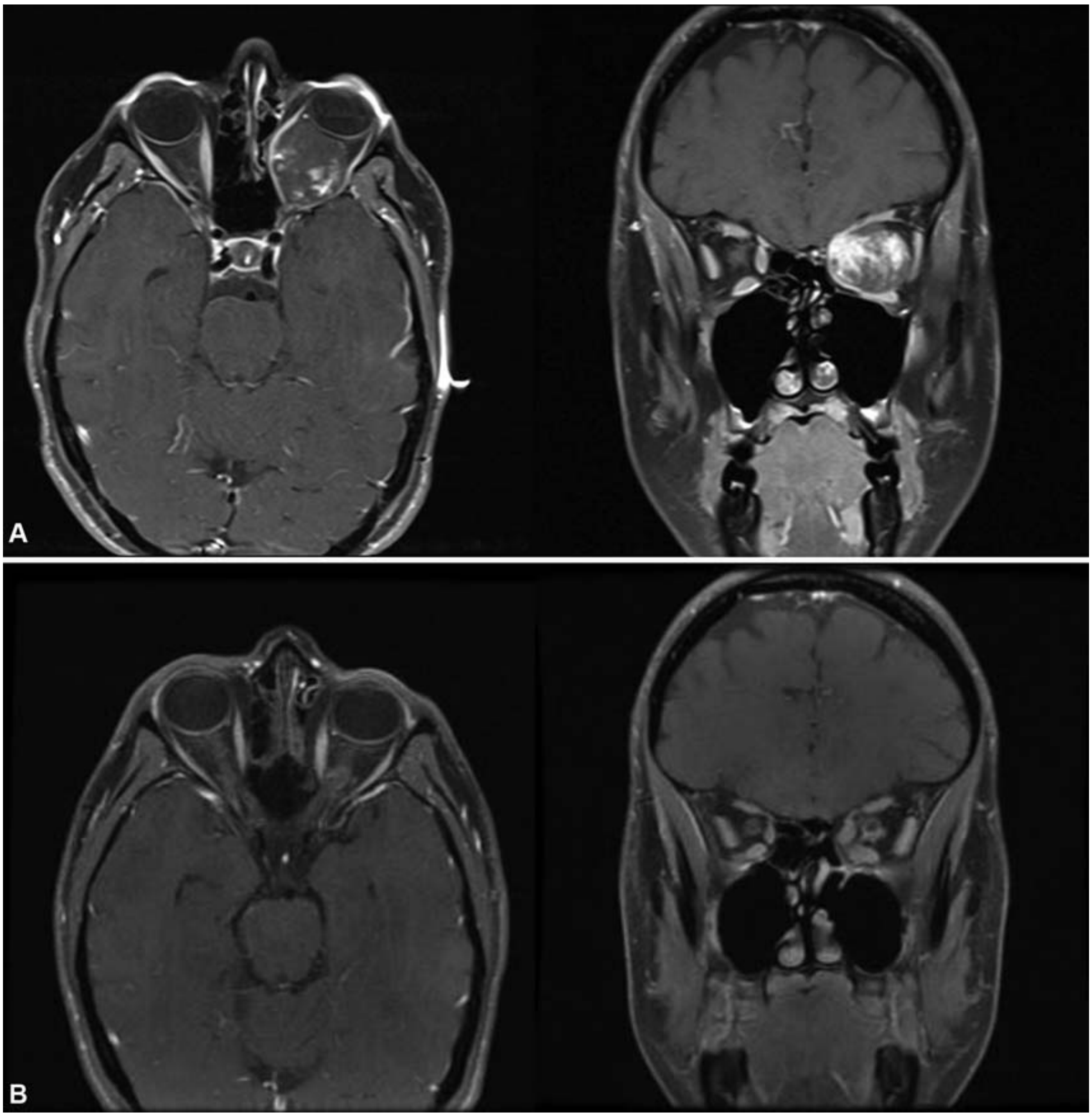

Fig. 5 (**A**) Preoperative-enhanced T1 MRI of cavernous hemangioma (Case 3). (**B**) An 18-month postoperative scan. MRI, magnetic resonance imaging.

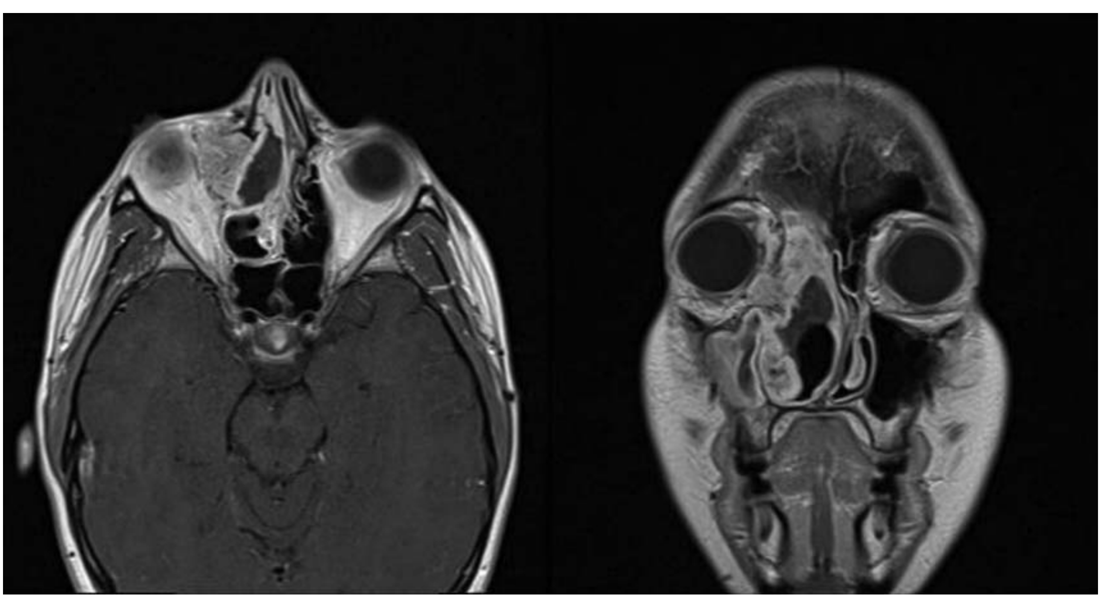

Fig. 6 Preoperative-enhanced T1 MRI of esthesioneuroblastoma (Case 4). MRI, magnetic resonance imaging.

the orbit, the optic nerve/ophthalmic/central retinal artery complex, determines the most advantageous approach to its removal. The use of a team with members from different surgical disciplines allows for the free consideration of this.

Conflict of Interest
None declared.

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