

## Endoscopic treatment of orbital tumors

Francesco Signorelli, Carmelo Anile, Mario Rigante, Gaetano Paludetti, Angelo Pompucci,  
 Annunziato Mangiola

Francesco Signorelli, Carmelo Anile, Angelo Pompucci, Annunziato Mangiola, Department of Neurosurgery, Catholic University School of Medicine, 00168 Rome, Italy  
 Mario Rigante, Gaetano Paludetti, Department of Otolaryngology, Catholic University School of Medicine, 00168 Rome, Italy  
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**Correspondence to:** Francesco Signorelli, MD, Department of Neurosurgery, Catholic University School of Medicine, Largo Agostino Gemelli, 8, 00168 Rome, Italy. [francesco.signorelli1984@gmail.com](mailto:francesco.signorelli1984@gmail.com)

**Telephone:** +39-06-30154120

**Fax:** +39-06-3051343

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to intraconal lesions may also require deinsertion of extraocular muscles, with subsequent impact on extraocular mobility. Recently, minimally invasive techniques have been proposed as valid alternative to external approaches for selected orbital lesions. Among them, transnasal endoscopic approaches, "pure" or combined with external approaches, have been reported, especially for intraconal lesions located inferiorly and medially to the optic nerve. The avoidance of muscle detachment and the shortness of the surgical intraorbital trajectory makes endoscopic approach less invasive, thus minimizing tissue damage. Endoscopic surgery decreases the recovery time and improves the cosmetic outcome not requiring skin incisions. The purpose of this study is to review and discuss the current surgical techniques for orbital tumors removal, focusing on endoscopic approaches to the orbit and outlining the key anatomic principles to follow for safe tumor resection.

**Key words:** Orbit; Orbital tumor; Endoscopy; Surgery; Approach

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**Core tip:** Recently, minimally invasive techniques have been proposed as valid alternative to external orbital and transcranial approaches for selected orbital lesions. Among them, transnasal endoscopic approaches, "pure" or combined with external approaches, have been reported, especially for intraconal lesions located inferiorly and medially to the optic nerve. Herein we review and discuss the current surgical techniques for orbital tumors removal, focusing on endoscopic approaches to the orbit and outlining the key anatomic principles to follow for safe tumor resection.

### Abstract

Different orbital and transcranial approaches are performed in order to manage orbital tumors, depending on the location and size of the lesion within the orbit. These approaches provide a satisfactory view of the superior and lateral aspects of the orbit and the optic canal but involve risks associated with their invasiveness because they require significant displacement of orbital structures. In addition, external approaches

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## INTRODUCTION

Orbital tumors encompass a broad spectrum of benign and malignant lesions intrinsic to the orbit, like cavernous hemangiomas, schwannomas, hemangiopericytomas, and tumors starting from the skin, sinuses, nose, cranial bones and cerebral parenchima with secondary orbital invasion. Cavernous hemangiomas are the most frequent intraorbital primary tumors in adults, representing 4% of all orbital tumors and 9%-13% of all intracranial cavernous hemangiomas<sup>[1]</sup>.

Exact location within the orbital cavity and size of tumors are crucial elements involved in the surgical planning.

External surgical approaches to the orbit have already extensively been described. Lateral orbitotomy or the transconjunctival approach are usually performed for the removal of small tumors located on the temporal compartment or on the orbital base; supraorbital approach allows the resection of lesions located dorsolaterally; transcranial approaches, like pterional approach, are indicated for large tumors even located medially to the optic nerve.

Recently, minimally invasive techniques have been proposed as valid alternative to external approaches for selected orbital lesions. Norris and Cleasby firstly described the use of the endoscope in orbital surgery in 1981<sup>[2]</sup>. Endoscopic management of orbital lesions was initially reported in 1985 by Norris *et al.*<sup>[3]</sup>. Thereafter different endoscopic approaches have been described for orbital tumors removal with the aim of reducing the morbidity rate related to a more significant tissue manipulation while preserving cosmesis. Transnasal endoscopic approaches are also well established for different non-tumoral conditions like Graves' ophthalmopathy<sup>[4]</sup>, medial wall fracture<sup>[5]</sup> and traumatic optic neuropathy unresponsive to steroids<sup>[6]</sup>.

Several authors have reported on different transnasal endoscopic approaches for orbital tumors removal, especially for intraconal lesions located inferiorly and medially to the optic nerve. Most surgeons performed "pure" endonasal approaches; some others described combined "open" orbital and endoscopic surgery<sup>[7]</sup>. Mir-Salim *et al.*<sup>[8]</sup> removed an intraconal cavernous hemangioma through an endonasal transtethmoidal route with the aid of microscope. The expanded endonasal approach allows the removal of all types of skull base tumors, including posterior and medial orbital lesions<sup>[9]</sup>.

Very recently, direct transorbital endoscopic approaches have been described for posterior lateral orbital tumors removal<sup>[10]</sup>.

The aim of the present study is to review and discuss the current surgical techniques for orbital

tumors removal, focusing on endoscopic approaches to the orbit.

## OPERATIVE TECHNIQUES

### External approaches

Lateral orbitotomy, providing a wide exposure of the lateral orbital compartment, is universally indicated for extra- and intraconal lesions situated therein, such as pleomorphic adenomas and cavernous hemangiomas<sup>[11-15]</sup>.

The transconjunctival approach is restricted to smaller basal and medial intra- and extraconal tumors, such as cavernous hemangiomas, schwannomas, hemangiopericytomas, and isolated neurofibromas<sup>[15,16]</sup>. This approach implies incision of the conjunctiva inferiorly along the corneal edge and caudal opening of the flap<sup>[17,18]</sup>.

The supraorbital approach *via* eyebrow incision is indicated for lesions located superiorly to the optic nerve<sup>[19]</sup>. This approach is more suited to large extraconal lesions in which added exposure is needed<sup>[15]</sup>.

The pterional approach offers excellent exposure of the posterior orbit and wide visualization of the superior orbital fissure and the anterior temporal fossa, also allowing access to the upper part of the medial orbit<sup>[19,20]</sup>. The contralateral pterional was considered suitable for lesions located medially and inferiorly to the optic nerve in the posterior intraconal space<sup>[20]</sup>.

### Endonasal microsurgical approach

Mir-Salim *et al.*<sup>[8]</sup> described an endonasal transtethmoidal approach performed with the aid of microscope in order to remove a cavernous hemangioma. They performed ethmoidectomy and then resected the lamina papyracea between the sphenoid sinus wall, skull base and ethmoid. After mobilization of the medial rectus muscle, the cavernoma was removed under microscopic control.

### Endonasal endoscopic approaches

Transnasal endoscopic approach is indicated for intraconal lesions located inferiorly and medially to the optic nerve, especially cavernous hemangiomas, which can be easily manipulated with low risk of rupture thus resulting ideal for the transnasal management<sup>[21]</sup>.

Usually sphenoethmoidectomy is performed by means of a 0° optic with a 18 cm rigid endoscope followed by a maxillary antrostomy to gain access to the floor of the orbit. Then with a 45° optic the bony medial part of lamina papyracea and the floor of the orbit are identified and removed. After careful dissection from the overlying bone, the periorbita is sharply opened with sickle knife and endoscopic microscissors. Then the tumor become visible and is removed after dissection from the periorbital fat.

For intraconal lesions located inferiorly and medially, the dissection corridor is between the medial and inferior rectus muscles. They are identified and

isolated with vessel loop as they insert on the globe and then retracted. Once the intraconal corridor is developed, the tumor is identified and removed with limited bipolar cautery and extensive sharp dissection.

### Combined approaches

Campbell *et al.*<sup>[7]</sup> described a combined transcaruncular and a transnasal endoscopic cryo-assisted approach to remove a cavernous hemangioma. The Cryo-probe allowed freezing both at the tumor capsule surface and within the stroma, thus facilitating the endoscopic removal of the fluid-filled lesion.

Tsirbas *et al.*<sup>[22]</sup> performed, through an inferior transconjunctival orbitotomy, an orbital floor dissection subperiosteal to the posterior orbit to identify the anterior limit of the cavernous hemangioma. Then, by means of a transantral endoscopic approach, they removed the posterior orbital floor and gained the posterior orbital periosteum overlying the lesion, which was incised.

### Transorbital endoscopic approach

A transconjunctival transorbital endoscopic approach was recently described by Rivkin *et al.*<sup>[10]</sup> for the resection of a pleomorphic adenoma located in the posterior lateral orbit. The authors performed a lateral conjunctival incision, posterior to the lateral rectus muscle. No bone removal, craniotomy, or skin incision were required. Then, under the vision of a 0° endoscope, they made an incision in the periosteum and the tumor was delivered into the periosteal pocket.

The endoscope is a useful adjunct also for the treatment of selected orbital roof lesions, such as cholesterol granulomas, orbital dermoids and Langerhans cell histiocytosis involving the anterior portion of the orbital roof. In these cases bone removal is often needed for adequate visualization behind the superior orbital rim<sup>[23]</sup>.

Table 1 summarizes the hallmarks of aforementioned surgical approaches.

## DISCUSSION

Posterior orbit harbors pivotal neurovascular structures like the optic nerve, the ophthalmic artery and vein, and the ocular muscles and their nerves all crowded in a very narrow cone-shaped surgical field<sup>[22]</sup>. Thus the surgical approach planning is extremely challenging.

The location of the lesion inside the orbit is the most relevant parameter to consider in choosing the surgical approach. The approach is also decided on the basis of the extension and the type of the tumor<sup>[20]</sup>. The experience of the surgeon especially in endoscopic sinus surgery has also a role in the surgical planning process.

Traditional external orbital and cranial approaches involve risks associated with their invasiveness because they implies manipulation of delicate orbital structures

like extraocular muscles, which in some case need to be deinserted, with subsequent impact on extraocular mobility<sup>[9]</sup>.

Moreover lateral orbitotomy and supraorbital approach carry the disadvantage of postoperative scar. At the other hand the transconjunctival approach, which implies incision of the conjunctiva inferiorly along the corneal edge, without bone removal or skin incision, carry the disadvantage of a limited view; thus it is not suitable for large lesions.

The pterional approach offers an optimal view of the posterior orbit and of the upper part of the medial orbit thus providing good control of the optic canal, the superior orbital fissure and the anterior temporal fossa<sup>[24]</sup>. Extensive tissue manipulation connected with this approach can lead to the risk of injuring the frontal lobe along with intraorbital bleeding, cerebral edema and seizure.

The endonasal microscopic approach to the retrobulbar region described by Mir-Salim *et al.*<sup>[8]</sup> provides a limited view compared with the narrowness and deepness of the surgical field.

Different transnasal endoscopic approaches have been reported on for the treatment of orbital tumors, especially for intraconal lesions located inferiorly and medially to the optic nerve and the extraconal lesions adjacent to the paranasal sinuses.

A safe resection of orbital tumors through an endonasal endoscopic approach requires the respect of some key anatomic principles<sup>[9]</sup>. First, it is critical to avoid crossing the optic nerve. Thus, tumors that are localized to the superior/lateral orbit are contraindicated for an endonasal approach. Second, entering through the lamina papyracea below the level of the ethmoidal foramina allows sparing of the ethmoidal arteries thus reducing the risk of retrobulbar hemorrhage and vision disturbances. Finally, the dissection should occur between muscle groups rather than through individual muscles for preservation of function.

The avoidance of muscle detachment and the shortness of the surgical intraorbital trajectory makes endoscopic approach less invasive, thus minimizing tissue damage<sup>[25,26]</sup>. Endoscopic approach carries also the advantage to decrease the recovery time and to improve the cosmetic outcome not requiring skin incisions<sup>[26]</sup>.

Orbital surgery carries the risk of damaging the intraorbital structures because of a local increase of intraorbital pressure. In transnasal procedures, the removal of the lamina papyracea allows partial displacement of orbital content, otherwise collapsed in a not distensible space<sup>[25]</sup>.

The endoscopic surgery also carries some risks and distinct disadvantages. The first one is the lack of three-dimensional vision. However, moving the endoscope actively, thereby providing some sense of depth, can simulate a three-dimensional perception.

**Table 1** Hallmarks of the surgical approaches to the orbit

Approach	Ref.	Location	Size	Contraindication	Advantages	Disadvantages
Lateral orbitotomy	Arai <i>et al</i> <sup>[14]</sup> Carta <i>et al</i> <sup>[11]</sup>	Lateral, dorsal and basal to the ON	All	Medial location	Good view	Cosmetic scar
Transconjunctival	Cheng <i>et al</i> <sup>[16]</sup>	Basal and medial intra-extraconal tumors	Small	Medium size and large tumors	Minimally invasive	Limited view
Supraorbital	Maus <i>et al</i> <sup>[19]</sup>	Superior, lateral and medial	All	Basal location	Good view	Cosmetic scar
Pterional	Schick <i>et al</i> <sup>[24]</sup>	Superior and medial	All	Basal location	Good view	Invasive
Contralateral pterional	Hassler <i>et al</i> <sup>[20]</sup>	Superior and medial	All	Basal location	Good view	Invasive
Endonasal microsurgical	Mir-Salim <i>et al</i> <sup>[8]</sup>	Intraconal lesions	All	Lateral location	Three-dimensional view	Long approach distance and limited view
Endonasal endoscopic	Castellnuovo <i>et al</i> <sup>[25]</sup>	Inferior and medial to the ON, paranasal sinuses	Medium	Lateral location	Minimally invasive, better cosmetic outcome, short recovery time	Two visual dimensions, Small operative field
Combined	Transcaruncular and transnasal endoscopic cryo-assisted	Orbital apex	All	Solid consistency	To ablate vascular tumors	Cosmetic scar
	Inferior transconjunct, orbitotomy and transantral endoscopic	Posterior orbit, orbital apex	All	Medial location	Improved visualization and limited manipulation within the orbit	Cosmetic scar
Transorbital endoscopic	Rivkin <i>et al</i> <sup>[10]</sup>	Posterior lateral	All	Medial location	Decreased surgical morbidity, improved cosmesis	Two-dimensional view, learning curve

ON: Optic nerve.

Furthermore, the endoscopic sinus surgery allows a limited degree of space for instruments. Considering that the hemostasis could be difficult and risky in a small operative field, the endoscopic transnasal approach should be restricted mostly to benign tumors or inflammatory processes and not be used for highly vascularized tumors<sup>[27]</sup>.

Muscatello *et al*<sup>[21]</sup> noted that the consistency of cavernous hemangioma is ideal for the transnasal approach, because these lesion maintain their shape and can be easily manipulated without excessive risk of rupture. Moreover, unlike cerebral ones, which are not encapsulated, orbital cavernous hemangiomas are well encapsulated, probably by a specific reaction of the orbital fatty tissue<sup>[28]</sup> and the extracapsular dissection can be easily performed<sup>[23]</sup>. Furthermore, they consist of endothelium-lined dilated spaces with a low blood flow; this condition allows the surgeon to manipulate and to remove the lesion piecemeal when this procedure is necessary.

While endoscopic endonasal surgery is limited to intraconal lesions located inferiorly and medially to the optic nerve and to extraconal ones adjacent to the paranasal sinuses, tumors located in the lateral portion of the orbit can alternatively be managed using a

transconjunctival transorbital endoscopic approach, as recently described by Rivkin *et al*<sup>[10]</sup>. Comparing with external approaches, this technique proved to share the same advantages of the endonasal corridor such as decreased morbidity and post-operative pain, reduced hospitalization and improved cosmesis. Similarly, the technique has the limit of a two-dimensional view and the learning curve that may be required for surgeons less familiar with this surgery. Larger tumors or masses with bone involvement may still require standard open approaches.

## CONCLUSION

Endoscopic endonasal approach allows a useful and safe route to reach and manage orbital lesions located medially to the optic nerve. More traditional surgical approaches are still widely preferred but imply major surgical morbidity and invasiveness, so they can be avoided whenever an endoscopic endonasal approach should be performed. A multidisciplinary team with expertise in endoscopic techniques is mandatory.

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