Endoscopic orbital decompression of complications of thyroid-related orbitopathy

Graves' disease is an autoimmune disorder affecting the thyroid, orbit and skin. Approximately 50% of patients with this disorder develop orbital manifestation of dysthyroid orbitopathy. Fewer than 5% of such patients have disease that is severe enough to require surgical decompression of the orbit (Metson and Samaha, 2004). The extensive muscle enlargement limits globe movement in extremes of gaze which will cause diplopia. Visual loss in Grave's disease is uncommon, occurring in only 2 to 7% of patients (Kountantakis et al, 2000; Kuppersmith et al, 1997). Exopthalmos in Grave's disease is thought to result from the deposition of immune complexes in the intraocular mucles and fat which in turn leads to edema and fibrosis (Tandon et al, 1994). The resultant increase in intraorbital pressure pushes the globe forward causing proptosis. If this proptosis become severe enough, the eyelids cannot close properly and chemosis with or without exposure keratitis of the cornea may occur. Furthermore, the crowding of the orbital apex by the obviously enlarged extraocular muscles places pressure on the optic nerve. Stretching of the optic nerve by increasing proptosis may result in the development of optic neuropathy and visual loss. If medical treatment fails (high dose steroids with or without low-dose radiotherapy) , surgical decompression of eyelid is indicated(Cook et al, 1996).

Removing one or more of the bony walls can decompress the contents of the orbit. The least amount of decompression would be achieved with medial wall removal, but the most physiologic and least to cause complications like globe displacement and diplopia. Endoscopic orbital decompression affords maximal orbital decompression at the orbital apex, an area that is not fully accessible via the external or transantral routes (Metson et al, 1994). Many techniques have been described for decompressing the orbit but the order of the procedures is that orbital decompression first, then strabismus and lastly the eyelid.

Indications and contraindications

The primary indication for the surgery is exopthalmos, either for cosmetic reasons or when vision is deteriorating and steroids and radiotherapy treatment has failed. The most common indications for such surgery are exposure keratopathy and optic neuropathy that have been refractory to conservative measures. Patients with diplopia from dysthyroid orbitopathy may require decompression before strabismus surgery to reaccess the globe and improve the predictability of muscle adjustments. Some surgeons who consider aesthetically undesirable proptosis to be an indication for orbital decompression have performed such surgery for its cosmetic benefits.

Contraindications to endoscopic orbital decompression include acute sinusitis and anatomic abnormalities of the maxillary bone. Endoscopic decompression may be technically difficult in patients with very small maxillay sinuses or thick orbital walls. These features are easily identified on computed tomography (CT) scan of the orbit and sinuses, which should be obtained on all patients before surgery.

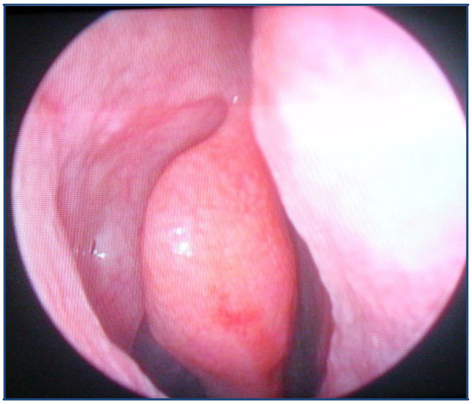
Useful instruments

- A long-shanked drill with a course diamond burr (Storz, Medtronic Xomed) and good irrigation system to keep the bone cool.
- Image guided surgery

Endoscopic technique

The patient is placed in a supine position with head slightly elevated. Packing that has been soaked in a 4% cocaine solution is placed in the nasal cavity to initiate mucosal vasoconstriction. Both eyes are exposed in the surgical field. If general anaesthesia is used, the corneas are covered with protective shells. Under endoscopic visualization, submucosal injections of 1% lidocaine with epinephrine are administered along the lateral nasal wall and middle turbinate. If a septal deviation precludes endoscopic access to the middle meatus region, a septoplasty is performed before orbital decompression.

The bones removed in endoscopic decompression include the medial wall of the orbit and the portion of the floor that is medial to the infraorbital canal. The procedure is initiated with an incision through the uncinate process. This incision is made just posterior to the maxillary line, a bony eminence that extends from the anterior attachment of the middle turbinate to the root of the inferior turbinate(Fig 10). The maxillary sinus ostium is then generously enlarged to provide optimal exposure of the orbital floor to prevent obstruction of the maxillary sinus by the decompressed globe. Bone is removed in the posterior direction to the level of the back wall of the sinus. Anterior removal is terminated at the thick bone of the frontal process of the maxilla, which protects the nasolacrimal duct. The ostium is enlarged superiorly to the level of the orbital floor and inferiorly to the root of the inferior turbinate. A 30-degree endoscope is used to identify the infraorbital nerve along the roof of the sinus (Fig 11).

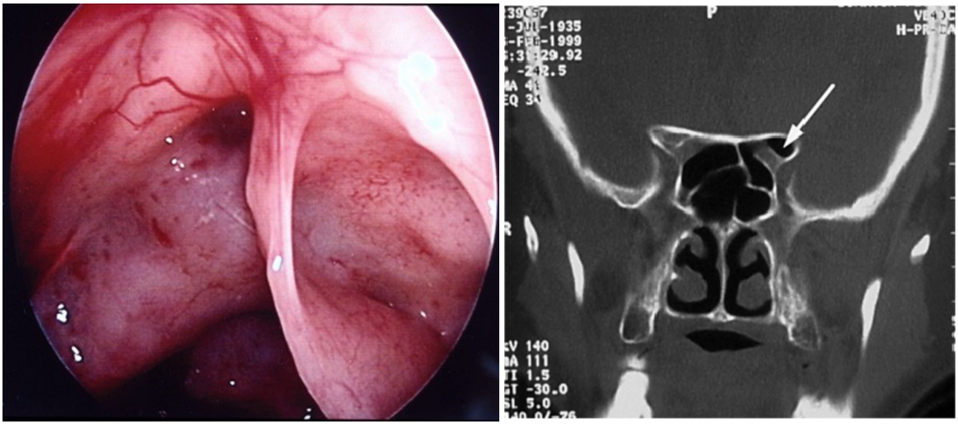


A zero degree endoscopic view of left lateral nasal wall showing the maxillary line and uncinate process

A 30 degree endoscopic view showing evidence of wide right middle meatal antrostomy with infraorbital indentation in the roof of the maxillary sinus

An endoscopic sphenoethmoidectomy is then completed as described by Stammberger

(1991) and Kennedy (1985). The degree of pneumatization of the sphenoid determines whether the optic nerve indents or even dehiscent in its lateral wall. Similarly, if the posterior ethmoid sinuses envelop the optic nerve before it reaches the sphenoid sinus, am Onodi cell may be present (Fig 12).The anterior and posterior ethmoid arteries are identified along the ethmoid roof. The middle turbinate that serves as a landmark during the sphenoethmoidectomy is removed before opening the lamina papyracea to optimize exposure to the medial orbital wall and facilitate postoperative cleaning. The skeletonized lamina papyracea is gently penetrated with a small spoon curette. Bony fragments of lamina papyracea is lifted in a medial direction to avoid perforation of the underlying periorbita. This elevation may also be performed with a periosteal elevator or delicate Blakesley forceps(Stortz, Germany). If surgery is performed using local anaesthesia, additional injections may be necessary to desensitize the medial orbital wall. Anaesthetic agent is injected just deep to the periorbita through the bony opening in the lamina.

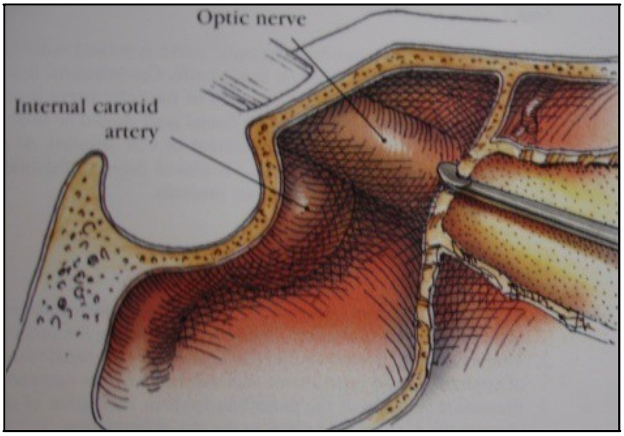


(a) (b)

An intra-operative endoscopic view (a) and coronal CT scan view (b) showing an Onodi cell

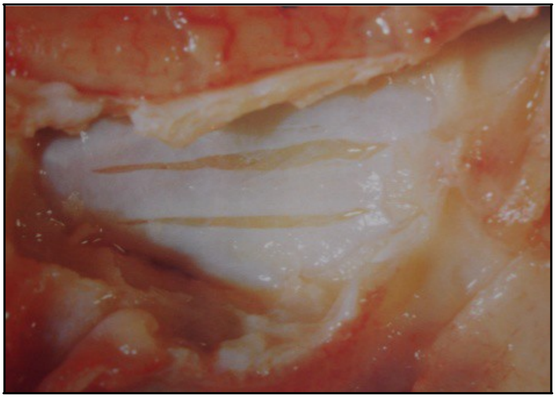
Bone of the lamina papyracea is removed in a superior direction toward the level of the ethmoid roof. The frontal recess is the most anterior superior portion of the ethmoid sinus, which communicates with the frontal sinus. Removal of the lamina papyracea in this region can cause postoperative obstruction of the frontal sinus by herniated fat. As dissection continous in a posterior direction toward orbital apex, thicker bone and underlying periorbita are generally encounterd within 2 mm of the sphenoid face. This thickening represents the annulus of Zinn, from which the extra ocular muscles(EOMs) originate and through which the optic nerve passes (Fig 13). This landmark represents the posterior limit of dissection and does not need to be removed. In cases of neuropathy, bone removal proceeds more posteriorly and may extend to the lateral wall of the sphenoid sinus.

Fragments of bone are cleared from the anterior end of lamina papyracea where it joins the lacrimal bone. Dissection in this region may be facilitated by use of an angled spoon curette and 30-degree endoscope (Stortz, Germany). The thick white fascia of the lacrimal sac may be uncovered but should not be opened. Firm bone anterior to the maxillary line protects most of the sac, so it should not be removed. Removal of the bone along the medial orbital floor can be most technically challenging aspect of this surgery. A spoon curette is used to fracture the bone in a downward direction. This bone may break apart in several small fragments with a natural cleavage plane along the infraorbital canal. Use of a 30-degree endoscope may facilitate visualization within the maxillary sinus and aid in the identification of the infraorbital nerve which serves as the lateral limit of bone removal.

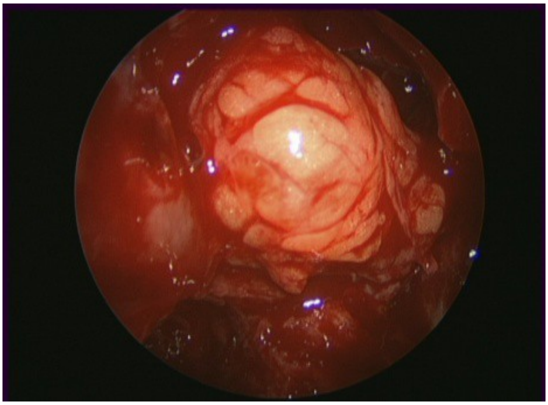


A diagrammatic sagittal section of left sphenoid and posterior ethmoids showing the thick bone at the annulus of Zinn at the junction of the orbital apex and sphenoid sinus

After the periorbita has been fully exposed and cleared of bony fragments, it is opened with a sickle knife(Stortz, Germany). The incision is usually commenced in front of the sphenoid sinus. Care is taken to keep the tip of the blade superficial to avoid injury of the underlying orbital contents especially the medial rectus muscle, which may be enlarged secondary to dysthyroid orbitopathy. Incision of the periorbita is extended along the ethmoid roof and the orbital floor. A horizontal strip of periorbita overlying the medial rectus muscle is preserved (Fig 14). This fascial sling serves to decrease prolapsed of the muscle and is thought to reduce the incidence of postoperative diplopia (Metson and Samaha, 2002). However, in patients with optic neuropathy, maximal decompression is needed and the fascial sling is sacrificed to allow for wider excision of the periorbita which is removed eventually with angled Blakesley forceps. At the completion of the procedure, the generous prolapsed of the orbital fat into the opened ethmoid and maxillary sinuses should be observed(Fig 15)



A 70 degree endoscopic view showing an emergency horizontal orbital decompression incisions of the periorbita extending from the ethmoidal roof to the orbital floor for thyroid related orbitopathy



A 30 degree endoscopic view showing prolapsed of orbital fat into the nasal cavity on balloting the right eye

A lateral orbital decompression may be performed at this time, depending on the extent of patient's disease and the degree of additional decompression desired. Due to the prior medial decompression, the orbital contents are easily retracted in a medial direction to provide excellent exposure of the lateral bony wall, which is removed or contoured. Concurrent excision of excess intraconal fat may also be performed if necessary. Bilateral orbital decompressions may be performed concurrently or as a staged procedure.

Nasal packing is avoided in order to prevent compression of the optic nerve, which is rendered increasingly vulnerable by the decompression. The patient is discharged the morning after surgery with a prescription for oral antibiotics and instructions to begin twice-daily nasal saline irrigations with a bulb syringe. During postoperative visit a week later, residual debri is cleared from the nasal cavity under endoscopic guidance.

In some cases, local anaesthesia may be preferred to general anaesthesia. These situations include patients who have an only-seeing eye, significant medical comorbidity, or a strong preference for local anesthesia.

The use of local anesthetic enables the surgeon to monitor the patient's vision on a continuous basis during the surgery and reduces the likelihood of occult injury to the optic nerve (Metson et al, 1994). Ideal sedation is achieved with intravenous bolus of propofol, 0.4 to 0.8mg/kg, administred before local injection, followed by maintenance infusion of 95 to 75 ug/kg during the procedure. Submucosal infilteration of 1% lidocaine with epinephrine 1:100,000 is performed exactly as described for the procedure utilizing general anaesthesia. Patients may report discomfort during removal of the lamina papyracea, and this may require a small additional infiltration of anaesthetic solution into the periorbita.

Complications

Diplopia is a relatively common sequela of endoscopic orbital decompression reported in 15 to 30 % of postoperative patients. This complication can be the result of change in the vector of pull of the EOMs. Diplopia that is present preoperatively is usually not improved by this surgery. Patients with preexisting or new-onset post-operative diplopia frequently require strabismus surgery. It is essential that all patients be informed of the possibility of postoperative double vision before undergoing orbital decompression.

Techniques to decrease the incidence of new-onset postoperative diplopia, including the preservation of the fascial sling of periorbita to prevent prolapsed of the medial rectus muscle, have been mentioned (Metson and Samaha, 2002). To decrease the incidence of postoperative diplopia, the use of balanced decompression technique is advocated. This technique involves performing external lateral wall decompression at the time of endoscopic medial wall decompression to reduce pressure on the medial rectus muscle while simultaneously increasing the degree of ocular recession.

Postoperative bleeding after endoscopic orbital decompression is managed by direct caurterization of the bleeding site. Nasal packing is avoided in these patients to avoid pressure in the region of the optic nerve. The incidence of sinonasal infection post-surgery is minimized with the routine use of postoperative antistaphylococcal antibiotics.

Postoperative epiphora may occur if the nasolacrimal duct is transected during the maxillary antrostomy. This complication is readily treated with an endoscopic DCR. Blindness and cerebrospinal fluid rhinorrhea are also potentially serious complications of orbital decompression but rare.

Endoscopic orbital decompression should be performed only by surgeons with extensive experience in endoscopic intranasal techniques. A team approach, which uses the skills of both an Otolaryngologist and an Opthalmologist during the performance of this procedure is highly recommended.

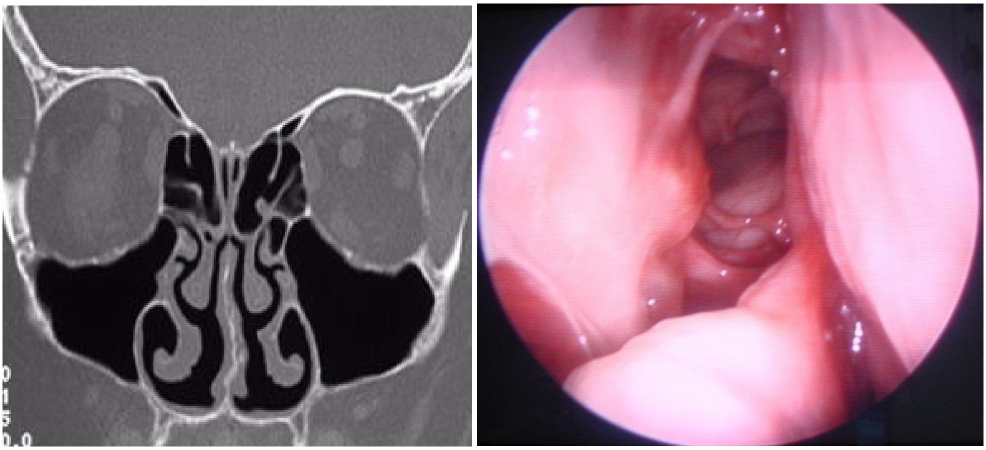
Tips for successful surgery

Orbital decompression for thyroid-related orbitopathy is an effective method for reduction of proptosis for cosmetic proptosis, eye complications from exposure of the cornea and visual loss. The amount of regression of proptosis is related to the number of walls removed during surgery. It is believed that three-walled decompression may give a more balanced decompression with less likelihood of postoperative diplopia.

Endoscopic orbital decompression for acute orbital hemorrhage

The procedure of choice is lateral canthotomy and inferior cantholysis with of course cold dry compresses as tolerable. This is performed for ‘orbital compartment syndrome’ due to orbital bleeding, emphysema or tumor. For orbital decompression, lateral canthotomy alone is not sufficient and the inferior eyelid should be completely free to allow anterior displacement of the globe. Drainage of any kind is only indicated if this is not helpful. The problem with drainage is that the bleeding is diffuse and not confined to one compartment. Endoscopic drainage is actually performed to remove adjacent orbital wall and open the periosteum to allow decompression of orbital soft tissues. It is important to note that the same can be achieved with the faster canthotomy and inferior cantholysis.

Invariably the anterior ethmoidal artery(AEA) can be located one cell behind the frontal recess(Fig 16 a, b). The size of the so called supra-orbital cell (Bolger & Mann, 2001) varies: it can be small or large. The AEA can often be seen on CT scan, (Fig 10) particularly as it enters the orbit where it produces a fluted defect in the lamina papyracea(LP). The more pneumatized the supra-orbital recess, the more vulnerable it is to damage. Often the ethmoidal bulla (EB) attaches to the skull base and the AEA lies within the roof and is 1-2 mm behind the attachment of the anterior wall of the EB to skull base. If the frontal recess (FR) does require opening, it is best approached anteriorly, away from AEA if the landmarks are poor owing to previous surgery or bleeding. As the AEA is sometimes dehiscent, it is advisable not to grasp polyps in this area if one is unable to identify the anatomy clearly. Often the FR can be found by following the intact anterior wall of the ethmoidal bulla superiorly.



(a) (b)

A coronal CT imaging showing an indentation of right anterior ethmoidal artery at the region of frontal recess (a) and a 70 degree endoscopic view showing indentation of the artery in the same patient(b).

The AEA is dehiscent at some point in the majority of patients (Lang, 1989). It is essential to avoid tearing it for it can cause marked bleeding. If it is transected and retracts into the orbit, a marked increase in pressure in the posterior compartment of the eye can occur and place the retinal artery and its supply to the retina at risk. If it is torn, gentle bipolar diathermy will arrest the bleeding but this should be performed with great care to avoid transecting the remaining segment of the artery.

Endoscopic orbital decompression for orbital sub-periosteal abscess

Rhinosinusitis in children is not a surgical disease, and therefore the treatment is medical with systemic antibiotics such as clavulinic acid and ampicillin(Augmentin). The priority should be safety in any treatment as the problem usually resolves with time without intervention. Growth and maturation of the immunological response to pathogens play a major role in resolution of the disease (Jones, 1999; Howe & Jones, 2004).

Patients presenting with orbital complications of sinusitis commonly have a degree of cellulitis and edema (chemosis) around the eye with associated proptosis (Fig 24). This may be associated with some restriction of eye movement. Patients typically present with history of nasal obstruction, purulent rhinorrhea and facial pressure or pain. Nasal endoscopy reveals an inflammed and oedematous nasal mucosa with usually presence of pus in the middle meatus.

Picture of a child with a left orbital cellulitis

If a subperiostal abcess is suspected, a CT scan of the parananasal sinuses with contrast will present a mass located on the lamina papyracea or in relation to the frontal sinus. The rim of the mass will enhance with the contrast. Moreover, the proptosis will be visible on the axial scans.

The external approach is quick and easy and the abscesss can usually be rapid and safely drained. If the surgeon is a skilled and experienced endoscopic sinus surgeon, endoscopic drainage of the subperiosteal abscess can be performed. The problem with this procedure is the significant vascularity that is associated with acute sinusitis. If the mucosal surface is touched with an instrument or endoscope, it will usually bleed and an inexperienced surgeon may lose orientation and complications may occur as a result of poor visibility during the surgery. Frequent packing with decongested soaked neuropatties throughout the procedure helps to minimize the bleeding but will not control it entirely. In a patient with acute sinusitis, the anaesthetist needs to optimize the patient's hemodynamics parameters to create an optimal surgical field.

The surgical approach is to perform an uncinectomy and enlarge the maxillary ostium to a moderate degree. Uncinectomy alone without antrostomy carries the risk of postoperative closure of the maxillary sinus because the inflammation and edema predisposes to scarring and adhesion formation. Clearance of the frontal sinus depends on whether the frontal sinus is thought to be the origin of the subperiosteal abscess. If the abscess is located adjacent to the ethmoidal sinuses, clearance of the bulla ethmoidalis and posterior ethmoids is performed with identification of the lamina papyracea. The lamina papyracea over the subperiosteal abscess is widely exposed and removed. If the abscess is related to the floor of the frontal sinus, it can still be drained endoscopically. A minitrephine is usually placed in the frontal sinus before dissection of the frontal recess. This aids in identification of the frontal outflow tract. The frontal recess is cleared and the frontal ostium identified. The lamina papyracea directly behind the the lacrimal sac is removed and using a curette, the orbital periostium is kept intact and gently pushed laterally while the curette advances into the subperiosteal abscess and the abscess drained (Wormald PJ, 2005).

A malleable suction is introduced into the cavity and any fibrin within the cavity is removed. A corrugated Pendrose drain is slid into the abscess cavity and left in place, draining the abscess cavity into the ethmoid sinuses for 1 to 2 days before being endoscopically removed. Endoscopic removal of the subperiosteal abscess remains highly effective but it must be emphasized that the surgeon should be very experienced.

Although endoscopic drainage of subperiosteal and other orbital abcesses is becoming more common, the efficiency of narrow surgical drainage via an endoscopic approach has not been thoroughly been evaluated (Page and Wiatrak, 1996). Similarly, although endoscopic treatment of frontal sinus is less invasive than open frontal surgery, it also has a lower reported success rate (Metson and Gliklich, 1998).

Indications for CT scan

- Unable to accurately assess vision, gross proptosis, opthalmoplegia, deteriorating visual acuity or colour vision, bilateral edema, no improvement or deterioration at 24 hours or a swinging pyrexia that does not resolve within 36 hours

Tips for successful surgery

Endoscopic decompression of a subperiosteal abscess should only be performed by very experienced endoscopic sinus surgeons because the surgical field can be very bloody, which can significantly increase the degree of difficulty and the likelihood of complications. If the surgeon is not experienced, then the abscess should be drained via an external incision.