OPEN ACCESS ATLAS OF OTOLARYNGOLOGY, HEAD & NECK OPERATIVE SURGERY

ENDOSCOPIC TRANSORBITAL SURGERY: MEDIAL ORBITAL (PRECARUNCULAR) APPROACH

Darlene Lubbe

The precaruncular approach is indicated for the following clinical situations:

1. Ligation of anterior and posterior ethmoidal arteries
2. Multiportal surgery for optic nerve decompression. The precaruncular portal is especially useful to retract herniating fat and muscle laterally to allow for both posterior orbital and optic nerve decompression
3. Minimally invasive surgery for removal of medial orbital lesions – cavernous haemangiomas, pseudotumours and to biopsy medially located lesions
4. Access to lacrimal sac
5. To address blow-out fractures of the medial orbit and to reconstruct the medial orbital wall
6. Access to lateral aspect of ipsilateral sphenoid sinus
7. Access to contralateral sphenoid sinus for Sternberg canal defects
8. Access to medial cavernous sinus
9. Access to ipsilateral anterior cranial fossa / cribriform area / olfactory fossa
10. Drainage of medially located subperiosteal abscesses secondary to complicated sinusitis

Precaruncular approach compared to Lynch-Howarth incision

Access to the ethmoidal arteries is required to ligate the vessels with nasoethmoid traumatic fractures or to assist with haemostasis prior to resecting sinonasal tumours. The Lynch-Howarth incision has been the gold standard to approach these arteries, with the frontoethmoidal suture line said to be the optimal way of finding these arteries. However, this external approach should be replaced by the precaruncular approach to access these arteries for the following reasons:

Lynch-Howarth incision

- External facial incision can cause cosmetically unacceptable scars
- Dissection through skin, subcutaneous tissue, and orbicularis oculi muscle is required with suturing of the incision
- Bleeding can be encountered from the angular vessels

Precaruncular approach

- Provides access to
  - Ethmoidal arteries
  - Medial orbit
  - Lamina papyracea
  - Ethmoid and sphenoid sinuses
  - Optic nerve
  - Medial cavernous sinus
- Direct access without breaching facial skin
- Easy, quick, direct access without dissecting uninvolved tissue (skin, muscle, lacrimal system, sinuses)
- No suturing of skin incision required

Surgical Anatomy

It is important to understand the anatomy of the medial canthus, lacrimal system and the attachments of the medial orbital wall structures to the bony orbit prior to utilising this medial portal.

Medial canthus

The medial canthus is where the upper and lower eyelids meet. It includes the *canthal tendon* and *lacrimal canaliculi*. The canaliculi and tendon are superficial to the area of dissection and should be preserved if the dissection is done within the correct surgical plane *(Figures 1-3)*.

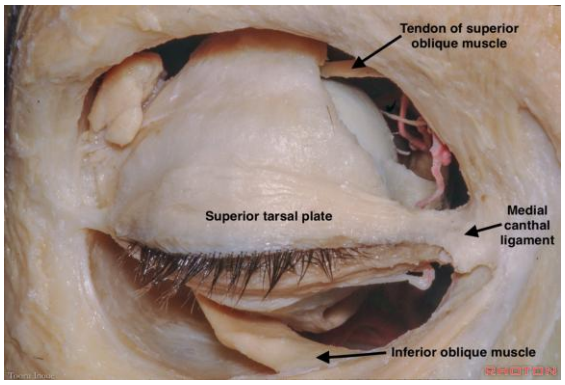

Figure 1: Right eye medial canthus (rhoton)

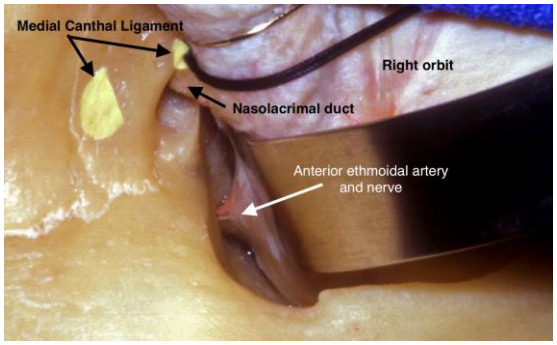

Figure 2: Right eye as seen from above with retractor retracting orbit laterally to show the anterior ethmoidal artery (rhoton)

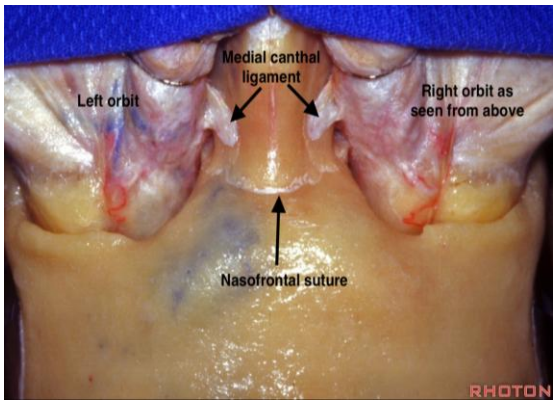

Figure 3: Medial canthal ligaments demonstrated from above (rhoton)

As the medial canthus is difficult to reconstruct, great care should be taken to avoid injury to these structures.

Lacrimal system

The lacrimal canaliculi run in a plane superficial to the plane of dissection of the precaruncular approach. The surgeon can cannulate the canaliculi after dilating the superior and inferior puncta to ensure that these structures are not injured during the surgery. If familiar with dacryocystorhinostomy (DCR) surgery, this is usually unnecessary *(Figures 4 & 5) (Chapter on DCR)*.

Figure 4: Lacrimal dilator, probes and irrigation

Figure 5: Probing and syringing of lacrimal system

The lacrimal sac and nasolacrimal duct lie below the frontoethmoidal suture line *(Figure 2)* and dissection of this area is unnecessary if doing an anterior and posterior ethmoidal artery ligation, accessing the medial orbit for orbital tumours, decompressive surgery or during multiportal surgery.

Attachments of medial orbital structures to bony orbit

The medial (precaruncular) portal is located between the attachment of the trochlea to the superior-medial wall of the orbit and the attachment of the inferior oblique muscle to the inferior orbit *(Figures 1 & 6)*.

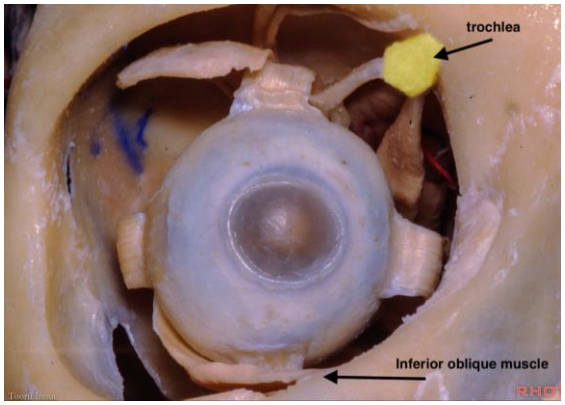

Figure 6: Right eye showing medial portal located between trochlea and insertion of inferior oblique muscle (rhoton)

It is important to remember that because these structures attach to the periorbital fascia, dissecting in the subperiosteal plane (between bone and periorbital fascia) is essential to avoid damage to these structures. It is usually unnecessary to dissect close to these structures unless an extended approach is required where the medial portal is combined with superior or inferior portals.

The ***trochlea*** is a cartilaginous sling that acts as a pulley for the superior oblique muscle. It is located approximately 1.5cm superior to the lacrimal caruncle [1] *(Figures 1, 6)*. The trochlear fossa is about 4mm from the orbital margin. This is where the pulley is attached.

The ***inferior oblique*** arises from the orbital surface of the maxilla, lateral to the lacrimal groove. It is the only muscle that ***does not*** originate from the common tendinous ring (annulus of Zinn). The muscle passes laterally, posteriorly and superiorly *(Figure 6)* and runs between the inferior rectus and the floor of the orbit and passes just underneath the lateral rectus muscle. It inserts onto the sclera between the inferior and lateral rectus muscles. Once again, one should ***avoid trying to identify this muscle*** during a pure medial approach and always remain in a subperiosteal plane when dissecting the periorbital fascia off the bony orbital wall.

Structures encountered during the medial precaruncular approach

Caruncle: The caruncle is a small mound of tissue located at the medial aspect of the eye *(Figure 7)*. Its function is most likely to directing the flow of tears to the lacrimal puncti.

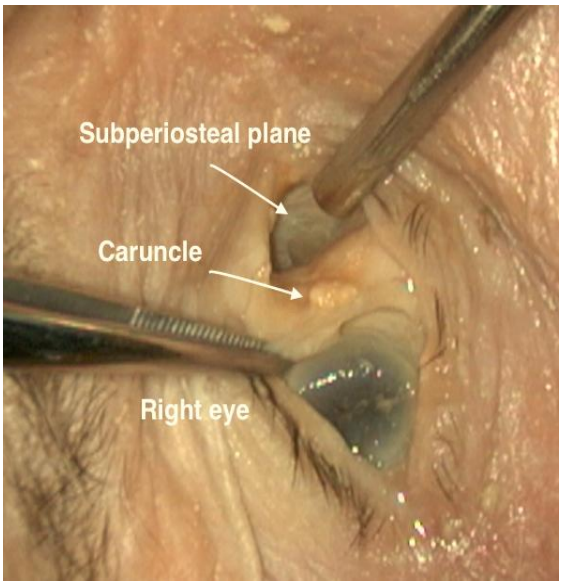

Figure 7: Caruncle of right eye

Horner's muscle: This is a small muscle that can be identified in the most anterior part of the medial orbit. It is one of the first structures encountered once the incision is made through the conjunctiva between the caruncle and the medial canthal skin *(Figure 8)*. Its function is not quite clear, but it most likely also assists with drainage of tears through the lacrimal system.

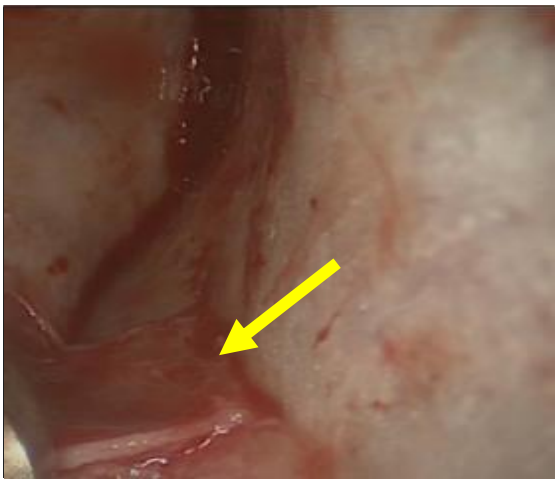

Figure 8: Horner's muscle identified in the right eye. The anterior ethmoidal artery lies 12mm posterior to this muscle

Frontoethmoidal suture line: This is only clearly visible in 50% of patients [2] and is therefore not a great landmark for the ethmoidal arteries. If visible, the ethmoidal vessels and nerves are found within the suture line or just above it *(Figure 9)*.

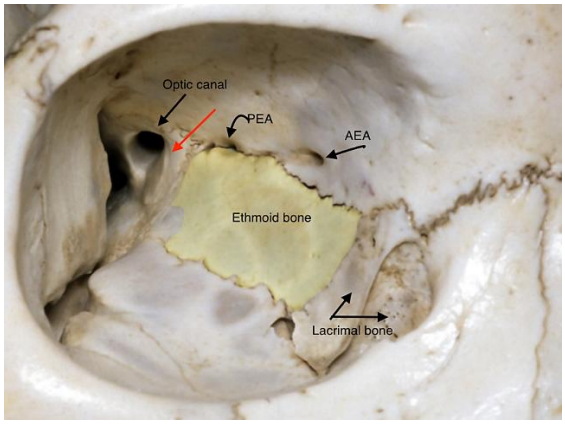

Figure 9: Right eye showing the frontoethmoidal suture line above the ethmoid bone (yellow) with the anterior ethmoidal artery (AEA) and the posterior ethmoidal artery (PEA) close to this suture line. Red arrow = bone of sphenoid body

If it is not clearly identifiable, then the nasion should be used as a landmark for the ethmoidal vessels as the ethmoidal arteries are at the same level as the nasion [2].

Anterior and posterior ethmoidal arteries: These are branches of the ophthalmic artery and are therefore branches of the internal carotid artery system *(Figure 10)*. The arteries run from the orbit to the nasal cavity (lateral-to-medial).

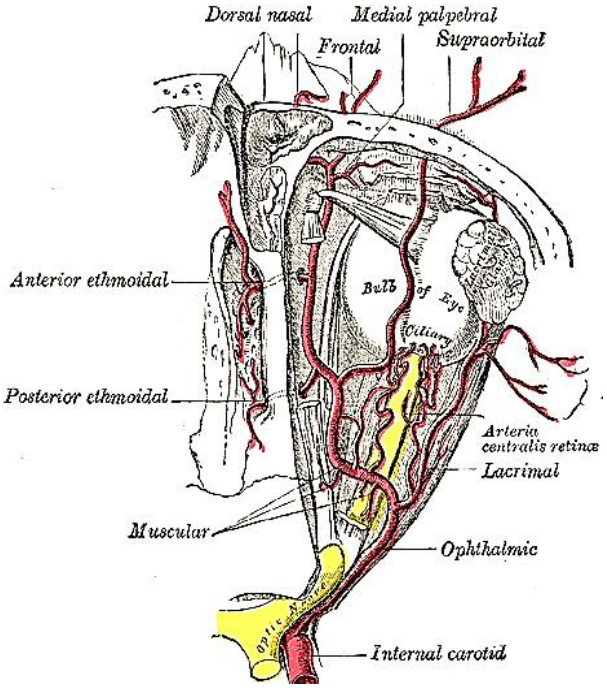

Figure 10: Ophthalmic artery gives rise to anterior and posterior ethmoidal arteries

There are numerous ways to find the arteries using their relationships to other structures:

1. The arteries are at the ***level of the nasion*** [2] or nasofrontal suture line *(Figures 2,3,9)*
2. Close to (within or above) the ***frontoethmoidal suture line***, which is only clearly visible in 50% *(Figure 9)*
3. 12mm posterior to ***Horner's muscle*** [2]
4. "***24-12-6 rule***": The anterior ethmoidal artery can be found 24mm from the anterior lacrimal crest; the posterior ethmoidal foramen is 12mm posterior to this; and the optic canal 6mm posterior to the posterior ethmoidal artery.

Note: When the precaruncular approach is used to ligate the ethmoidal vessels, the lacrimal crest does not have to be exposed.

Accessory ethmoidal arteries: These are often encountered between the anterior and posterior ethmoidal arteries. They usually are very small and are easily transected during elevation of the periosteal layer.

It is important to remember that the posterior ethmoidal artery can be absent. Great care should therefore be taken before cauterising or ligating a structure that could possibly be the optic nerve. If there is any doubt, it is safer to not cauterise the 2nd artery as any trauma to the optic nerve would lead to blindness.

Optic canal: The optic canal is found 6mm posterior to the posterior ethmoidal artery in the most posterior-medial aspect of the bony orbit *(Figure 11)*.

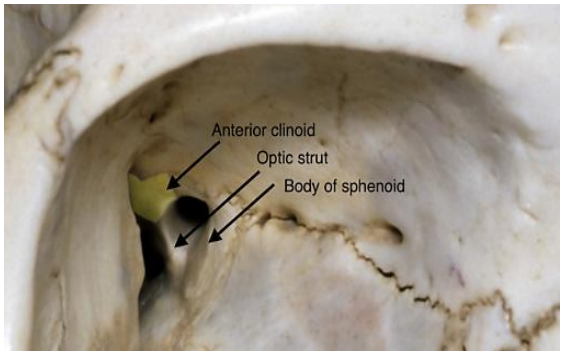

Figure 11: Right optic canal formed by the body and the lesser wing of the sphenoid See optic strut (inferiorly) and anterior clinoid (posteriorly)

It is located within the sphenoid bone and is bound medially by the body of the sphenoid and laterally by its lesser wing (optic strut) *(Figure 11).*

Indications for Precaruncular Approach
(See 1st page)

Preoperative planning

The need for imaging depends on the indication for surgery. For any ***surgery other than ethmoidal artery ligation, preoperative imaging is mandatory***. For simple ligation of the ethmoidal vessels, preoperative CT imaging is not required. If a patient has proptosis secondary to an intra- or extraconal lesion (space within the orbit outside the musculofascial cone), then preoperative CT and MRI is useful to assess the location of the lesion relative to the rectus muscles and optic nerve. Navigation is also useful to locate any pathology other than the ethmoidal arteries.

Ophthalmological examination is indicated for any patient who has orbital pathology, proptosis or visual abnormalities. It is important to document the visual acuity, visual fields if indicated, degree of proptosis and intraocular pressure prior to performing any surgery. The only indication for not performing these tests would be for ligation of the ethmoidal arteries in a patient with no orbital pathology or visual problems.

Preoperative counselling includes mentioning all the possible complications that could occur if any important structures are injured during this approach. It is important to explain to patients that this approach has been used since 2010 with very few (if any) complications reported in the literature. Injury of the lacrimal system can cause epiphora; injury to the ethmoidal vessels can cause an orbital haematoma or intracranial haemorrhage if there is backflow of blood; medial rectus muscle injury will cause diplopia; and optic nerve injury will cause blindness. Entering the medial cavernous sinus can injure cranial nerves III, IV, VI and the internal carotid artery causing a stroke or death.

It needs to be stressed that the precaruncular approach is minimally invasive, requires minimal dissection of uninvolved tissue (sinuses, lamina papyracea, rectus muscles), with little pain because of the little disruption of normal tissues, requires no suturing and allows early discharge from the hospital (often the same day) and minimal if any morbidity.

Surgical technique

1. Anaesthesia and positioning
2. Preoperative preparation & instruments
3. Surgical steps
4. Postoperative management

1. Anaesthesia and positioning

- Positioning is as for FESS surgery with the patient supine and head flat or flexed 15 degrees (See *Chapter on FESS*)
- The head is turned slightly to the side of the surgeon
- The surgeon always stands on the left of the patient (when facing the patient) for a left-handed surgeon, regardless of which eye needs to be addressed
- The author prefers total intravenous anaesthesia (TIVA), but it is essential to have a slow heart rate and normotensive patient to assist with haemostasis
- 1 Gram of IV Kefzol is given at induction because multiportal surgery is often performed – this means the eye could possibly be contaminated with nasal organisms if a transnasal approach is combined with a transorbital approach

2. Preoperative preparation and instruments

- If the endonasal route is to be used, standard packing techniques are used, using 2ml of 1:1000 Adrenaline topically on neurosurgical patties (See *Chapter on FESS*)
- Clean the eye prior to draping with either normal saline or diluted Betadine solution (unless allergic to iodine). It is important to instruct the scrub nurse not to clean the eye with any products that could potentially damage the cornea or irritate the sclera (e.g. Chlorhexidine solution)
- Inject 0.2ml local anaesthetic (1:80,000 Adrenaline with 2% Lidocaine) at the start of surgery, between the caruncle and the skin edge of the eye *(Figure 12)* for haemostasis during the initial dissection of the precaruncular portal
- It is important to keep the cornea moist or to protect it with a corneal protector throughout the procedure to prevent any corneal trauma, as drying of the cornea can cause corneal ulceration or keratitis

Figure 12: Injecting 1:80 000 Adrenaline with Lidocaine into the medial canthus

Instrument requirements

- Camera system
- Zero-degree 4mm standard 18cm endoscope (sinuscope)
- Standard FESS tray
- Additional essential instruments
  - Ribbon retractors / Dural retractors (on neurosurgery tray): Ensure that a variety of sizes (8mm, 10mm, 15mm) of retractors are available
  - Small cat's paw retractor
  - Suction Freer
  - Freer elevator

- Bipolar forceps (as used with tonsillectomy
- Ligaclip applicator

3. Surgical steps

- Identify the caruncle of the eye, grasp it with toothed forceps and retract it laterally *(Figure 13)*
- Incise the conjunctiva between the caruncle and the medial canthal skin with sharp iris scissors

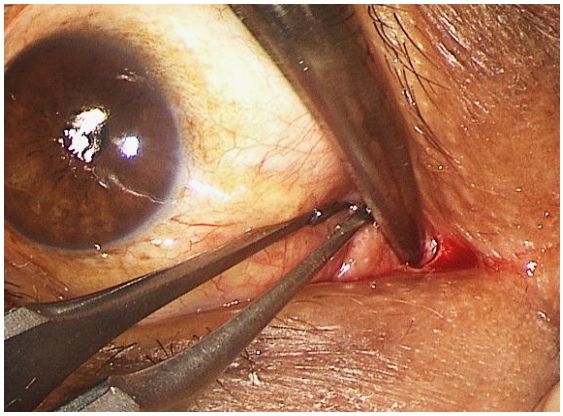

Figure 13: Right eye; retracting the caruncle laterally to incise between the caruncle and the medial canthal skin

- Aim the tip of the scissors towards the bone of the medial wall of the orbit, and dissect deep to the lacrimal canaliculi to prevent traumatising them *(Figure 14)*
- Surgeons not familiar with lacrimal anatomy should ask their ophthalmology colleagues to help dilate both puncti and insert probes into the canaliculi to ensure that the dissection is deep to these structures. Damaging the canaliculi could lead to epiphora *(Figures 4,5)*
- Once the tip of the scissors hits the bony orbital wall, the scissors is opened to 'spread' the orbital tissues to identify the bony orbital wall *(Figure 14)*
- Once bone is exposed, use a suction elevator, Cottle elevator or Freer's elevator to dissect in the ***subperiosteal plane*** between bone and periorbital fascia *(Figure 15a)*

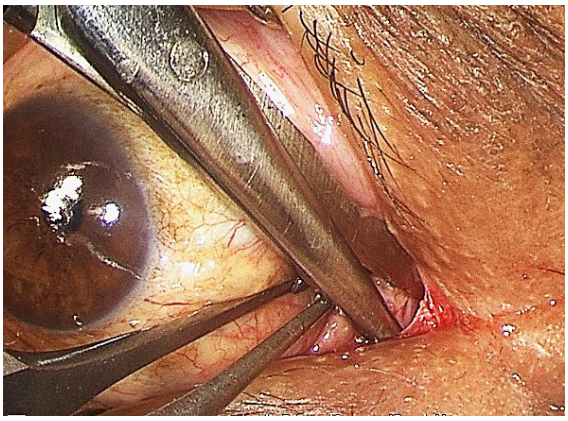

Figure 14: Right eye; precaruncular incision. Scissors inserted between caruncle and medial canthal skin, spreading tissues as soon as the bone is felt

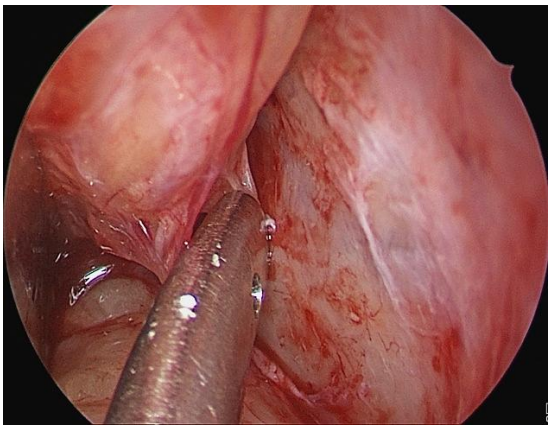

Figure 15a: Right eye; precaruncular incision with suction Freer elevator used to dissect in subperiosteal plane towards ethmoidal arteries

- As with septoplasty surgery, it is important to be in the correct plane to avoid breaching the periorbital fascia, as this would cause orbital fat to herniate into the surgical corridor and make further surgery difficult
- Use ribbon retractors to retract the orbital contents laterally *(Figure 15b)*. Ensure that a variety of sizes of ribbon retractors (8mm, 10mm, 15mm) is available

Figure 15b: A ribbon retractor is used to retract the orbit laterally

- Take great care with the amount of traction applied to the eye by the surgical assistant, especially at the posterior aspect of the orbit where excessive pressure with the retractor can cause damage to the optic nerve or the medial rectus muscle
- Insert the endoscope into the surgical portal as soon as the subperiosteal plane can be visualized – usually within 1cm of the initial incision
- It is easier to find the exact plane using the endoscope
- The endoscope initially rests on the ribbon retractor for stability
- The author uses a standard 4mm 18cm sinus endoscope, but a 3mm wide angled scope will give good visualisation with a bit more space for manipulating instruments within the surgical corridor
- The rest of the procedure is performed using the endoscope
- Check the pupil for any changes in size or shape every 5 minutes while retracting as pupillary changes indicate raised intraocular pressure which can cause visual loss
- A small cat's paw retractor can be used to retract the medial canthus medially to 'open up' the surgical portal between the ribbon retractor and the cat's paw
- Continue the dissection in the subperiosteal plane, dissecting more superiorly towards the level of the nasion with the suction Freer elevator
- The first structure encountered is ***Horner's muscle***
- The dissection may well be more posterior to Horner's muscle, so if it is not easily identified then proceed to find the next landmark
- Try to identify the ***frontoethmoidal suture line***
- If this is not possible, then determine the level of the ***nasion*** – this is the level at which the ethmoidal vessels will be found
- Find the ***anterior ethmoidal artery;*** it is easily identified as a 'tenting structure' as the suction elevator elevates the periosteum off the bony orbital wall *(Figure 16)*
- A bit of ***orbital fat*** often herniates through the periorbital fascia where the artery exits the orbit *(Video)*. This fat can also be used as a landmark to find the artery. In about 50% of females this fat is a constant landmark for the artery *(Figure 16)*

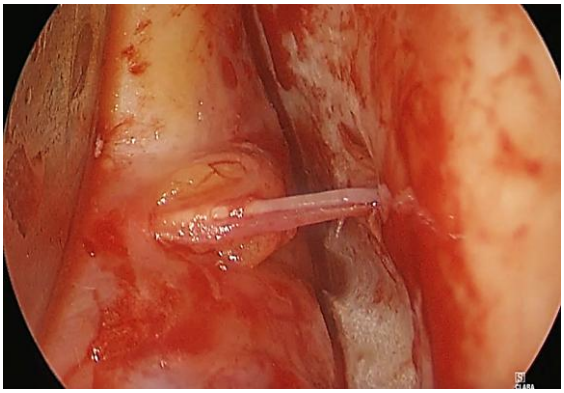

Figure 16: Right eye; anterior ethmoidal artery with a bit of fat herniating through the periorbital fascia

- Use a standard tonsil ***bipolar*** forceps to ***cauterise*** the ***anterior ethmoidal artery*** or apply a ***Liga clip*** *(Figure 17)*

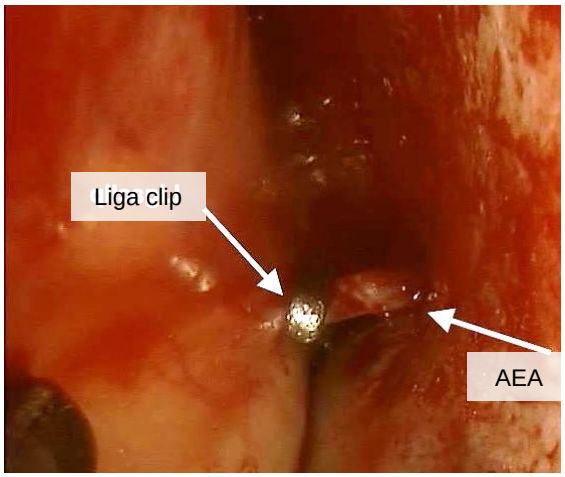

Figure 17: Right eye; anterior ethmoidal artery (AEA) has been clipped as the artery leaves the orbit

- Find the ***posterior ethmoidal artery*** 12mm behind the anterior ethmoidal artery *(Video) (Figures 18ab)*
- It is important to remember that there are often ***small accessory ethmoidal arteries*** and that the ***posterior ethmoidal artery may be absent***
- It is imperative to ***ensure that the optic nerve is not confused for the posterior ethmoidal artery***. Therefore contemplate carefully before ligating what you think is the posterior ethmoidal artery

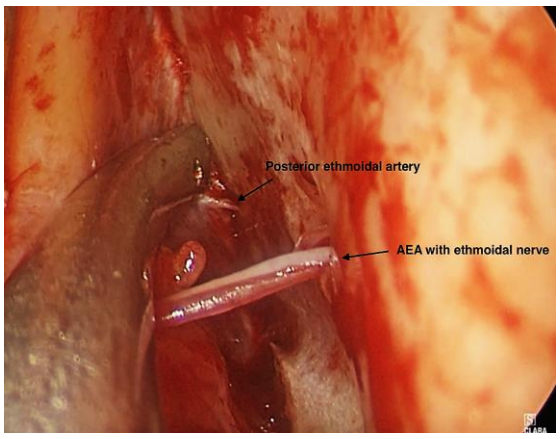

Figure 18a: Posterior ethmoidal artery 12mm posterior to AEA

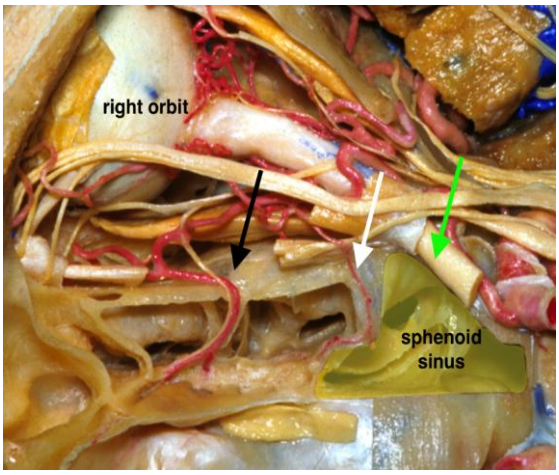

Figure 18b: Note close proximity between the AEA (black arrow), PEA (white arrow), and optic nerve in optic canal (green arrow) (rhoton)

Deciding how to proceed at this point depends on the indication for using the precaruncular approach

- If the aim of the surgery is to ligate the vessels, the surgical portal is irrigated with saline and nasal endoscopy is done to check that haemostasis has been achieved
- There is no need to suture the precaruncular incision

Precaruncular approach as extra portal during multiportal surgery for access to posterior orbit and for optic nerve decompression

These procedures require retraction of the orbital contents. They may be combined with an ipsilateral endonasal approach, or a binostril approach *(Figure 19, video)*. However, a precaruncular approach can be used on its own without an endonasal approach, thereby preserving the normal sinus anatomy.

Figure 19: Multiportal surgery using combined precaruncular and binostril approaches for optic nerve decompression

Indications for precaruncular approach to decompress the orbit include

- Thyroid orbitopathy *(Figure 20)*
- Severe proptosis
- Previous medial decompression has been performed and further decompression is required *(Figure 20)*

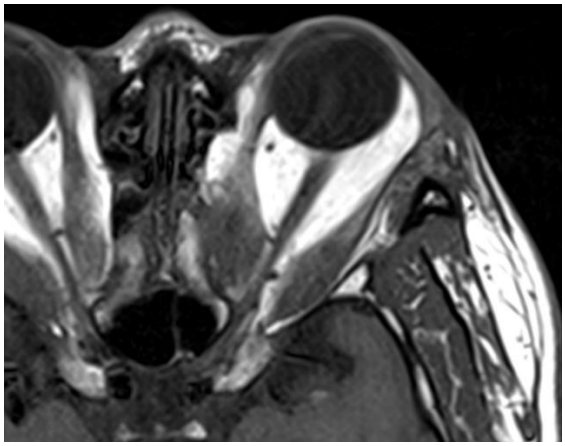

Figure 20: Previous medial decompression for thyroid eye disease with prolapse of orbital fat, making access to the posterior orbit and optic nerve difficult using a purely endonasal approach

Optic nerve decompression involves the following steps

- Remove the posterior 1/3 of the lamina papyracea by fracturing the lamina towards the ethmoid sinuses and away from the periorbita *(Figure 21)*

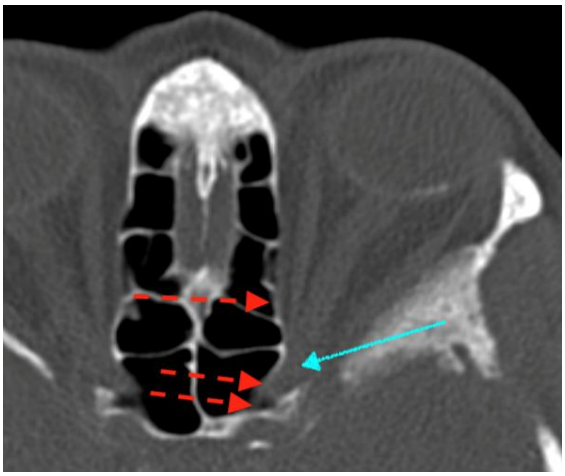

Figure 21: Optic nerve (blue arrow) within optic canal. Single red arrow shows where lamina is removed during optic nerve decompression. Double red arrow show extent of decompression needed

- Keep the nasal mucosa intact if an endonasal approach is not required
- The optic canal is found just below the level of the ethmoidal arteries (*Figures 11, 17ab, 22).* Therefore, ensure that dissection is carried out at this level
- Once the anterior face of the sphenoid is identified, the posterior ethmoidal artery can be visualised at the angle where the superior aspect of the sphenoid sinus face meets the skull base *(Figure 22)*
- Decompress the optic canal for a distance of 1cm from the optic protuberance to the opticocarotid recess (OCR) *(Figure 22)*

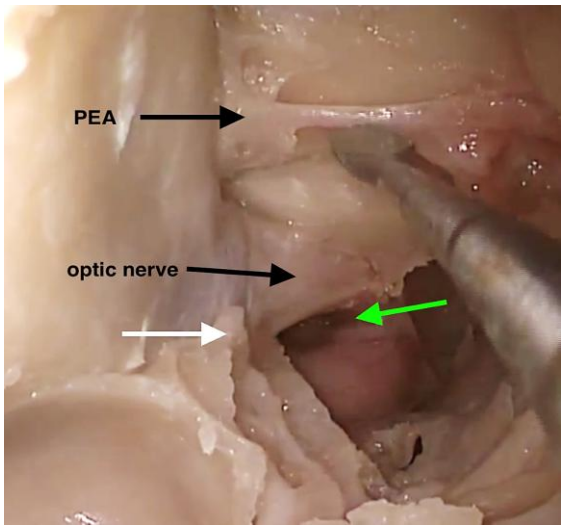

Figure 22: Right optic nerve decompression from the optic protuberance (white arrow) to the opticocarotid recess (green arrow)

- Beyond the opticocarotid recess the optic nerve runs intracranially. Decompression beyond this point is unnecessary unless the optic chiasm itself needs to be decompressed *(Figures 23, 24)*
- It is not the author's practice to fenestrate the optic nerve sheath during optic nerve decompression

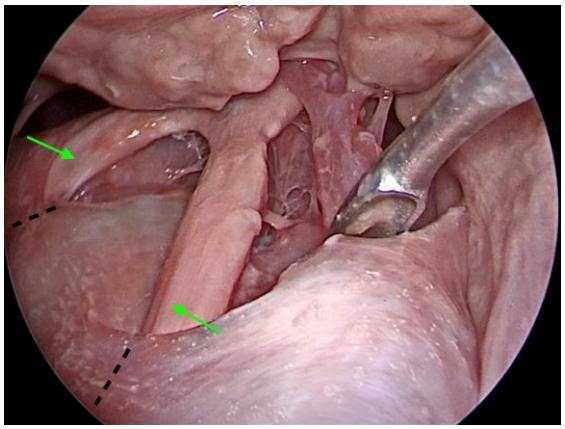

Figure 23: Optic nerves as seen from above through a lateral transorbital approach with 70-degree endoscope. Image shows the intracranial component of the optic nerves (green arrows) as it leaves the optic canal (black interrupted lines)

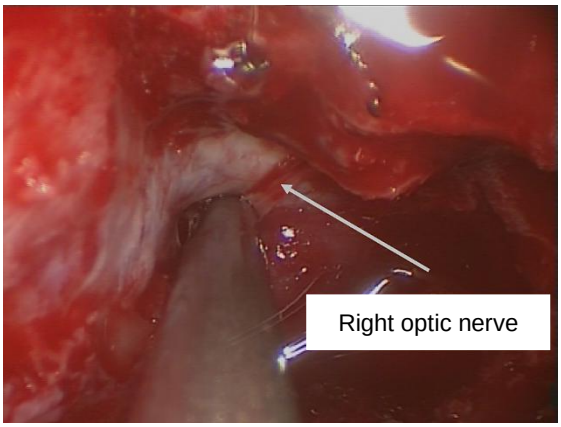

Figure 24: Right optic nerve decompression from the optic protuberance to the OCR

Precaruncular approach to medial orbital tumours

The precaruncular approach can be used to access ***intra- or extraconal lesions*** involving the medial orbit. ***Cavernous haemangioma*** is one of the most common pathologies encountered within the orbit and the precaruncular portal is the most minimally invasive approach to remove these lesions. It is important to study the ***imaging (CT and MRI) preoperatively*** and to assess the location of the lesion in relation to important orbital structures – the rectus muscles and the respective nerves that innervate them and vessels that supply them. An ***ophthalmological examination*** is essential, and all cases should be done in conjunction with an ophthalmologist.

- Incise the periorbital fascia
- Dissect bluntly to the lesion as previously described *(Figure 25)*
- Neurosurgical patties can be used to help retract fat during dissection
- No reconstruction is required as the medial wall of the orbit is not breached during surgery

Postoperative management

- At conclusion of the surgery, irrigate the surgical portal with normal saline

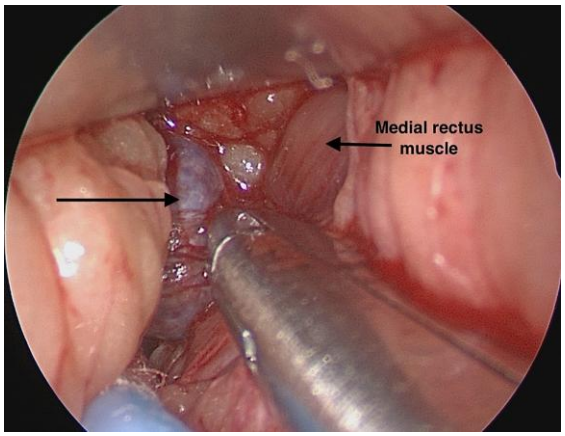

Figure 25: Right eye; precaruncular approach to intraconal cavernous haemangioma (black arrow)

- It is important to ensure that adequate haemostasis is achieved and that the ethmoidal arteries have been cauterised or ligated
- The surgical incision site is not sutured *(Figure 26)*

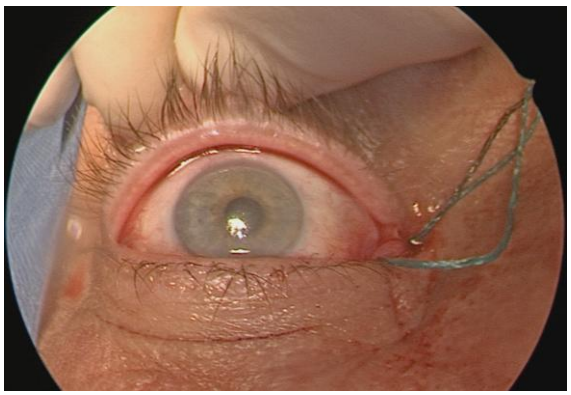

Figure 26: There is no need to suture the precaruncular incision. It is important to examine the pupil for asymmetry. Green threads are from neuropattie that is still in situ for haemostasis, and will be removed before end of surgery

- It is important to check the patient's vision and eye movements immediately after surgery
- A cold pack can be applied over the eye for a few minutes every hour in the first 24hrs to prevent bruising in the medial canthal area
- Topical chloromycetin ointment is applied in the corner of the eye for 3-5 days following surgery

References

1. Shin HJ, Gil YC, Shin KJ, et al. Identification of the trochlea with reference to the lacrimal caruncle, and its significance as a landmark in orbitofacial surgery. *J Plast Reconstr Aesthet Surg.* 2015 Mar;68(3):351-5
2. Cornelis M, Lubbe DE. *Clin Otolaryngol.* Pre-caruncular approach to the medial orbit and landmarks for anterior ethmoidal artery ligation: a cadaveric study. 2016 Dec;41(6):777-81

How to cite this chapter

Lubbe DE. (2019). Endoscopic transorbital surgery - medial orbital (precaruncular) approach. In *The Open Access Atlas of Otolaryngology, Head & Neck Operative Surgery*. Retrieved from https://vula.uct.ac.za/access/content/group/ba5fb1bd-be95-48e5-81be-586fbaeba29d/Endoscopic%20transorbital%20surgery%20-%20medial%20orbital%20%20_precaruncular_%20approach.pdf

Author

Darlene Lubbe MBChB, FCORL Professor
Division of Otolaryngology
University of Cape Town
Cape Town, South Africa
doclubbe@gmail.com

Editor

Johan Fagan MBChB, FCS (ORL), MMed
Emeritus Professor and Past Chair
Division of Otolaryngology
University of Cape Town
Cape Town, South Africa
johannes.fagan@uct.ac.za

THE OPEN ACCESS ATLAS OF OTOLARYNGOLOGY, HEAD & NECK OPERATIVE SURGERY

www.entdev.uct.ac.za