Complications of Endoscopic Sinus Surgery

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Introduction

Despite constant advances in surgical technique and instrumentation, the risk of serious complications during endoscopic sinus surgery (ESS) is always present due to close proximity with critical structures. The surgeon is responsible in minimizing the risks by a meticulous preoperative preparation, a careful operative technique and a correct postoperative care.

Complications following endoscopic sinus and skull base surgery are uncommon, but both trainee and experienced surgeons must maintain good awareness and understanding of them. Such knowledge should minimize the risk associated with surgery and also ensure that such unfortunate events are managed correctly to minimize their effect.

An integral component with surgery is the consent process, but for surgeons to do this effectively, they need to have a clear systematic way of classifying complications so that these can be explained both logically and in perspective to the patient.

Classification of Complications

Complications can be classified in several ways, such as by the anatomical system location, the severity or time related to surgery.

Anatomical classification: Complications can be described according to anatomical systems and location, such as vascular, neurologic, ophthalmic, wound healing or packing-related complications (Table 34.1).

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Table 34.1 Classification of complications

Vascular complications.
Injury to the anterior or posterior ethmoidal arteries sphenopalatine arteries or internal carotid artery (ICA): Consider major if the resulting of the damage affects cerebral circulation and in rare cases causing a significant drop in haemoglobin that may require transfusion
Neurological complications.
Cerebrospinal fluid (CFS) leak, tension pneumocephalus, meningitis, abscess, intracranial hemorrhage, direct brain injury or encephalocele formation
Ophthalmological complications.
Medial rectus injury, optic nerve injury, orbital haematoma and nasolacrimal duct injury that may result in double vision, loss of vision and epiphora
Other complications (wound healing and toxic shock syndrome)

Severity

Complications can be considered as major and minor. Major complications are those that might put the patient's life at risk; require urgent surgical intervention, blood transfusion or transfer to ICU; and cause significant risk of severe and/or long-lasting or permanent sequelae. Fortunately, complications are rare, occurring in 0.36–3.1%, but they still need to be explained and documented in the preoperative consent process, as well as a formal consent form, particularly with the ever-increasing risk of potential medicolegal claims [1].

Whilst minor complications are more common, they do not produce persistent significant adverse outcomes. These may include periorbital emphysema and ecchymosis, herniation of fat through the lamina papyracea, minor bleeds not requiring blood transfusion, facial swelling, hyposmia, facial hypoesthesia due to inflammation of the infraorbital nerve, synechia formation or atrophic rhinitis.

Time Related to Surgery

Complications may also be classified as intraoperative, early postoperative or late postoperative. One example is CSF leak, which, when recognized during surgery, can be fixed intraoperatively, thus minimizing the risk of an ascending bacterial meningitis or of an intracranial abscess.

Early postoperative complications, like hemorrhage or intranasal adhesions, may occur at any time right after surgery or up to a few weeks after the surgical procedure.

Late complications, such as a mucocele formation, may present many years after surgery. Whilst these categories are used for a more academic discussion and comprehensive overview, what is most important is recognizing and managing them appropriately in the clinical and surgical scenario.

The risk of some complications is increased and may be more severe according to surgical site and the individual sinus. Therefore, each particular sinus and its anatomical surroundings need to be fully addressed in every single patient in order to provide a safe and clean endoscopic approach.

Vascular Complications

Bleeding as a result of ESS may occur during or after the procedure. Most intraoperative bleeds are easily managed, as suction and coagulation devices should be easily accessible. Bleeding is therefore rarely registered as a complication.

Most epistaxes occur in the early postoperative course but is only considered as a major complication if the hemorrhage is severe enough to require nasal packing, surgical exploration to find the source or a blood transfusion. Postoperative hemorrhage is the most frequent of all major complications, accounting for 23–39% [2], but the need for blood transfusion is rare, being estimated at only 0.76% of patients in one large review [3].

Preoperative Scenario

Various risk factors may increase the risk of surgical bleeding. Such risk factors include pre-existing infection (sinusitis) or a range of systemic comorbidities such as hypertension, peripheral vascular disease, liver or renal diseases, chronic alcohol abuse and vitamin deficiencies that may need to be addressed and optimized both before and during surgery. Bleeding disorders such as haemophilia and von Willebrand disease will require clotting factor replacement or specialized pharmacotherapy that must be planned and managed in accordance with specialized haematological assistance.

Some medications, such as non-steroidal anti-inflammatory drugs, aspirin, warfarin, anti-platelet agents or other anticoagulants, will increase the risk of bleeding and must be managed appropriately before surgery. Aspirin and NSAIDS should be stopped at least 5–7 days before surgery, and warfarin doses need to be reduced and monitored by a daily INR level. However, should there be a risk to a patient having a period without anticoagulation, the need for surgery should be reassessed, or the operation may be covered by low-molecular-weight heparin.

Many patients are now taking anticoagulant therapy from a new group of medications known as direct oral anticoagulants, some of which are not reversible. These should be stopped 5–7 days prior to surgery, and if there is any element of doubt, haematological advice is sought.

Some herbal and alternative drugs may also severely affect coagulation pathways, such as ginseng, gingko and fish oil, and all herbal additives must be discontinued at least 7 days before surgery [4, 5].

Tips
Ensure that all medications and herbal additives that may alter coagulation have been identified before surgery and managed appropriately in the week before surgery.

Substitute anticoagulation treatment by subcutaneous heparin 5 days before surgery and monitor coagulation parameters prior to surgery.

Operative Scenario

It is really important to optimize the visual field in ESS surgery by minimizing bleeding. Important measures that help to achieve a blood-free field are as shown in Table 34.2.

Table 34.2 Recommended measures for minimizing bleeding

Minimizing bleeding	
Preoperative systemic steroids	Oral steroids reduce not only the size of polyps but also inflammation and the vascularity of polyps and sinus mucosa, thus reducing capillary bleeding
Preoperative antibiotics	Preoperative antibiotics may reduce infection in some patients (benefits in need of further research to clarify optimal dose and length of treatment [6])
Patient positioning	Reverse Trendelenburg and elevation of the head and thorax has a major impact on reducing bleeding during surgery [7, 8]
Topical and local vasoconstriction	Oxymetazoline reduces about 59% nasal mucosal blood flow and acts over 6 h [9]. Cocaine solution (in Moffet's solution) is a highly effective vasoconstrictor, but medical cocaine is not allowed in many countries
Arterial pressure and heart rate	A mean arterial pressure between 60 and 75 mmHg and an ideal heart rate at less than 60 beats/min [10]
Recommended anaesthesia	Total intravenous anaesthesia seems to reduce intraoperative bleeding (TIVA) [11]

Tips

At the end of the procedure, it is important to have the patient's blood pressure restored before extubation to best verify haemostasis. With a suction monopolar or bipolar instrument at hand, proceed to examine areas of common postoperative arterial bleeding after ESS (e.g. the region supplied by branches of the sphenopalatine and ethmoidal arteries; the posterior rim of an enlarged maxillary sinus in the middle meatus; the area of the sphenopalatine foramen, especially after a partial middle turbinate resection; the anterior face of an enlarged sphenoid sinus ostium supplied by the posterior nasal-septal branch and the skull base must be carefully inspected. Finally, the nasopharynx must be suctioned again and inspected for pooling of fresh blood, as the last manoeuvre performed in any endoscopic sinus procedure [2].

Nasal packing is usually not necessary after ESS when proper haemostasis is achieved. Some studies have provided evidence that, in terms of postoperative haemorrhage, the safety of the electrocauterization and no-packing technique after ESS is comparable with that of nasal packing [12].

If in doubt, a small fragmentable nasal dressing can be inserted in the middle meatus or areas where bleeding may be anticipated.

Postoperative Scenario

Severe haemorrhage may require intensive proactive interventional management, beginning with the patient's ABCs (Airway, Breathing and Circulation). However, patient airway intervention is exceedingly rare.

Nasal packs are ideally avoided as they induce discomfort and stress, additional bleeding when withdrawn, occasional septal perforation or rarely toxic shock syndrome. However, inserting nasal packing postoperatively risks additional trauma to fragile healing tissues and should be avoided whenever possible.

Should a severe epistaxis occur in an unpacked patient, a soft inflatable haemostatic device such as Rapid Rhino™ or a soft non-absorbable pack can be attempted until endoscopically controlled coagulation or clipping can be undertaken.

Tips

Severe bleeding typically arises from the sphenopalatine artery or its branches or the septal branches of the anterior ethmoidal artery.

Special attention must be paid to the posterior septal artery, a branch from the sphenopalatine artery, typically exposed and possibly traumatized during sphenoidotomy whilst enlarging the ostium inferiorly [13].

Management of Specific Arteries

Anterior Ethmoidal Artery Injury

The anterior ethmoidal artery (AEA), a terminal branch of the ophthalmic artery arising from the internal carotid artery, may cause significant haemorrhage during surgery, and a complete transection may result in retraction of the proximal (lateral) end into the orbit causing a rapidly expanding orbital haematoma. The position of the AEA on the CT sinus scan should be noted preoperatively from the coronal sections. It is typically seen as a pinch or "nipple" between the medial rectus and superior oblique muscles. The AEA runs in a mesentery in about one third of cases and tends to be associated with a longer lateral lamella of the olfactory fossa and steeper skull base at the ethmoidal level [14].

Tips

The best way of preventing damage to the AEA is either to avoid exposure by keeping dissection in front of the anterior wall of the bulla or by early endoscopic identification of the AEA at the insertion of the anterior wall of the bulla with the skull base or right behind it.

When using the microdebrider at this level, it is important to avoid movements in a posterior to anterior fashion. Instead, a perpendicular plane to the skull base is recommended as a safer alternative. A partial transection injury to the artery can be easily managed with a suction bipolar forceps. The management of a complete transection
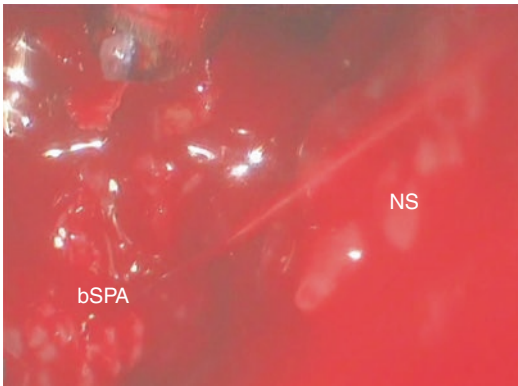
Fig. 34.1 Intraoperative arterial bleeding of a branch of the sphenopalatine artery middle turbinate resection. NS nasal septum, bSPAb branch of the Sphenopalatine artery

with retraction of the lateral end into the orbit will be discussed below.

Sphenopalatine Artery Injury

The sphenopalatine artery, with its many branches, provides the main vascular supply of the nasal cavity and can be a common source of arterial bleeding during surgery, particularly when performing surgery on the turbinates or a sphenoidotomy (Fig. 34.1).

Tips

Dissect the mucoperiosteum off the anterior wall of the sphenoid sinus and push it downwards before enlarging the natural ostium inferiorly with a 90° Kerrison punch. Should the posterior nasal artery be transected, the bleeding may cease spontaneously by vascular retraction and vasospasm, but coagulation of the arterial ends is recommended to bleeding from relaxation of vasospasm in the early postoperative phase with increasing blood pressure.

Internal Carotid Artery (ICA) Injury

The ICA is at risk even during standard ESS, especially when the intersphenoidal septum is oblique and attached to the thin bone overlying the carotid artery. The carotid can be dehiscent in around 10% of patients [15], and it is important to appreciate that the bone covering the carotid

artery is only about 1 mm thick. The risk to carotid artery injury is much higher during extended skull base surgery, especially in tumours that directly involve the carotid artery or in pituitary macroadenomas that extend into the cavernous sinus.

Tips

Powered instrumentation inside the sphenoid sinus should be strictly avoided. An oblique intersphenoidal septum should only be removed by drilling and never by twisting and fracturing. Also, a paraseptal approach to the sphenoid sinus is much safer for beginners than a transethmoidal approach, as this ensures that the surgeon is medial to the ICA.

Management of ICA Lesions

The best approach is careful preoperative planning with a detailed review of the preoperative CT scan and prevention of damage to the internal carotid artery.

Should the risk be foreseen, as in tumours surrounding the cavernous portion of the ICA or along its horizontal or intrapetrous aspect, then preoperative stenting can be considered and planned, thus avoiding a medical catastrophe. As always, the best recommendation is to have a "plan of action" beforehand, just in case.

Once the carotid artery is bleeding, the surgical team will experience significant stress, and this can lead to delayed or even wrong decision-making. If the risk of a carotid arterial bleed is likely, there should be a clear agreed protocol about the actions to be taken, including who shall be holding which instrument, the role of the individual team members and the order that things will happen. There are several training courses worldwide where surgeons can learn how to deal with such a massive bleeding. The courses also demonstrate that the reaction time is reduced when the exercise is repeated.

Fortunately, ICA lesions are isolated events. Therefore, there are no (prospective) studies about the ideal management, but only case reports. What makes sense is to firstly block blood loss by the fastest way possible to prevent hypovolemic shock. Current international con-

sensus recommends to then harvest a piece of muscle (from the thigh or sternocleidomastoid) of at least 1.5 x1.5 cm that is used to plug the hole in the ICA. This repair may be reinforced with any type of fibrin glue available. Needless to say, this procedure requires four hands, two good-working suction devices and the anaesthesiology team keeping the systolic pressure at a reasonable level to maintain cerebral perfusion.

Once bleeding is controlled, a pedicled septal flap can be rotated into the sphenoid to cover the muscle patch, and the sphenoid is then packed with Gelfoam.

Once control is achieved, an emergency angio-gram should be obtained. The images will then facilitate a decision as to whether endovascular intervention is required and whether the ICA should be stented or coiled. The nasal pack can be then removed after 5–7 days, but in a controlled theatre environment under general anaesthesia.

Tips

Do not try to coagulate or clip the ICA. It will not work.

Keep the muscle patch in place for 10 min with a mild compression.

Do not send the patient to neuroradiology before making sure that the bleeding is under control.

It is recommended to consult with a neurosur-geon/neurologist not only because of the risk of intracranial lesions but also for medicolegal rea-sons. ICA bleedings with intact dura will not track endocranially; however, with an open dura, the risk of intracranial bleeding and its conse-quences is very high.

The angiogram should be repeated at 6 weeks and 3 months later to exclude the development of a pseudo-aneurysm.

Neurological Complications

Cerebrospinal Fluid (CSF) Leak

Although a constant concern during surgery, most series report a rate between 0.17 and 0.8% [16]. Usually recognized by a clear washout of

fluid, it can also look like a sudden onset of brisk venous bleeding. A high index of suspicion for CSF leak must be kept in unilateral watery rhi-norrhoea, especially when surgery has been per-formed close to the skull base. The risks on an unrecognized or untreated postoperative dural defect including pneumocephalus, tension pneu-mocephalus, meningitis, encephalitis and epi-dural or subdural abscess may occur [1, 17].

Preoperative Scenario

A detailed preoperative assessment of the CT sinus scan images to identify any variations of skull base anatomy is key to preventing skull base lesions and intracranial complications [18]. Check the CT scan for any potential dehiscence, especially in revision cases or when the disease reaches the skull base. Classically, the Keros classification has been used to assess the depth of the olfactory fossa and subsequently the length of the lateral lamella. In types III or in an asymmetric skull base, one has to be more care-ful. A new classification system, based on the angle formed between the lateral lamella of the cribriform plate and the continuation of an hori-zontal plane passing through the cribriform plate, has shown to be more sensitive to anatomi-cal variations associated with CSF leak than the Keros classification [19].

Operative Scenario

Frequent locations for iatrogenic CSF leak are along the anterior vertical lamella at the *fovea ethmoidalis* constituting the lateral wall of the olfactory fossa (Fig. 34.2). Here, the thickness of the lateral lamella can measure as little as 0.1 mm being the thinnest area of the skull base. It is per-forated by the anterior ethmoidal artery (AEA). Cautery of the AEA close to the vertical lamella may produce adjacent thermal injury causing a CSF leak, this risk being even greater when using monopolar coagulation [15].

Another high-risk area is the frontal sinus dur-ing a frontal drill-out procedure (Draf III, modi-fied Lothrop) when drilling the bone close to the first olfactory fibres to create the "frontal T".

Also, enlarging the natural sphenoidal ostium superiorly during sphenoidotomy carries a risk of
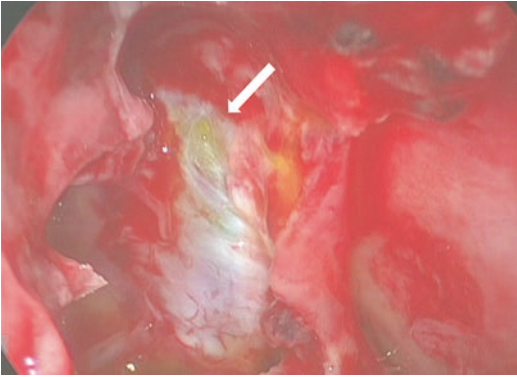
Fig. 34.2 Endoscopic view of a CSF fistula at the lateral wall of the olfactory recess (white arrow). Identification and repair during surgery enables a normal postoperative recovery

perforating the posterior ethmoidal roof as the natural ostium is close to the skull base.

Small skull base injuries that usually display a low-flow CSF leakage can generally be repaired with small grafts of fat, fascia or nasal mucosa. Larger skull base defects may require larger grafts of fascia lata and high-flow CSF leaks a pedicled flap.

Tips
Perform dissection along the skull preferably from posteriorly to anteriorly avoiding to apply any force towards the skull base.

Postoperative Scenario
An intraoperative but unnoticed CSF leak will display as a clear unilateral watery rhinorrhoea with a salty taste, especially when leaning forward or with the increase of intracranial and abdominal pressure (e.g. a Valsalva manoeuvre). Confirmation must be done by analysing a small sample of fluid for beta 2-transferrin assay or a beta-trace testing (faster and cheaper).

Intrathecal infiltration of 0.5–1 mL of 5% fluorescein can be applied around 30–60 min to better localize the dural defect, visualize the CSF flow and confirm that the reconstruction of the defect is watertight.

After reconstructing a large defect in expanded endoscopic skull base surgery, often supported by pedicled flaps, bed rest, head and chest eleva-

tion and stool softeners are recommended to prevent a recurrent leak during the healing phase and to facilitate and promote healing.

Lumbar drainage is recommended to decrease intracranial pressure for the initial 36–48 h after surgery on occasions where a high-flow CSF leak has been repaired. Persistence of CSF leak warrants further surgical exploration.

Prophylactic antibiotics after skull base reconstruction is still a matter of debate. In our patients, we routinely place one preoperative shot of an antibiotic with a good CSF penetration, such as first- or second-generation cephalosporin.

Associated Complications

Tension Pneumocephalus
Tension pneumocephalus is characterized by a steady increase of retained intracranial air through a dural defect that acts as a one-way valve. This process is hastened when a lumbar drain is placed. Rising air volume increases intracranial pressure, compromises cerebral perfusion and, in severe cases, results in brain herniation through the tentorium. Symptoms such as headache, lethargy or a decreased level of consciousness within a few hours after surgery should raise suspicion. An emergency CT scan is mandatory for definitive assessment. The "Mount Fuji sign" indicates an advanced and dangerous stage.

Management depends on the severity of the symptoms. Initial conservative management may include administration of 100% oxygen inhalation (most of the gas within the pneumocephalus is nitrogen). A lumbar drain, if present, should be clamped. Once the emergency situation has been resolved, the skull base defect needs to be localized and repaired.

Meningitis
Bacterial ascending meningitis or abscess formation may occur after resection of lesions of the skull base, with or without CSF leak, even years after the initial event. In some cases, an initial CSF leak may have gone unnoticed or conservative management measures were adopted. Responsible bacteria are those usually located in

the nasal cavity and nasopharynx, such as S*treptococcus pneumonia, Haemophilus influenzae* and, occasionally, *Moraxella catarrhalis* [20]. Symptoms include fever, headache, photophobia, neck stiffness and lethargy. Classically, physical examination may display positive Kernig or Brudzinski signs indicating the presence of meningeal irritation. The clinical workup includes a lumbar puncture, CSF culture and sensitivities, a contrast CT scan of the head with contrast to rule out an abscess and high-resolution HRCT of the skull base that may demonstrate a skull base defect. A dural defect that has caused intracranial infection should be repaired as soon as the patient is stable enough to undergo general anaesthesia.

Ophthalmic and Orbital Complications

Orbital complications from endoscopic sinus surgery (ESS) are fortunately uncommon, with analyses offering varying rates from 0.07 to 0.23% [1, 3].

Preoperative Scenario

Appreciation of anatomical variations on the CT scan is paramount. The preoperative assessment of the CT sinus scan should include a detailed review of the integrity of the lamina papyracea, orbital fat protrusion or an excessively medialized position of the lamina papyracea that may facilitate intraorbital injury. The position of the uncinate process in relation to the proximity to the medial orbital wall should be noted. The presence of sphenoethmoidal (Onodi) cells and the trajectory of the optic nerve within such cells should be noted.

Operative Scenario

Optic Nerve Injury
The optic nerve canal can usually be identified during ESS in the absence of excessive mucosal

disease. The thickness of the bone covering this nerve is variable and may be dehiscent. When the inferior clinoid process is highly pneumatized (Fig. 34.3), the optic canal may run through a mesentery within the sphenoid and the potential for injury to the optic nerve increases (Fig. 34.4). A sphenoethmoidal air cell (previously known as an Onodi cell – a posterolateral ethmoid cell that extends posteriorly and above the true sphenoid sinus) is an anatomical variant that places the optic nerve at increased risk of injury.

Fig. 34.3 Inferior clinoid process is highly pneumatized

Fig. 34.4 Accidental transection of a bone splinter through the optic nerve (arrow)

Injury of the optic nerve will induce an immediate decrease or loss of vision and a pupillary defect may be found.

In such a situation, immediate ophthalmological consultation is recommended, and nasal packing, if present, should be removed. High dose of intravenous steroids are commenced providing that there are no contraindications. In collaboration with an ophthalmologist, the patient should be taken back to the theatre for exploration and optic nerve decompression. Although there is no definitive proof that neither steroid therapy nor surgical decompression is superior to observation alone [21], we believe that, from a medicolegal point of view, a surgical revision is advised, unless the nerve has been transected.

Tips

Optic nerve injury can also occur from vasoconstriction. Avoid using cottonoids soaked in such drugs in the sphenoid sinus or close to the vicinity of the optic nerve.

An MRI may provide a good study of anatomical integrity of the optic nerve.

Infraorbital Nerve Injury

Injury to this terminal branch of the trigeminal nerve innervating the skin of the cheek may result in transient or permanent anaesthesia or paraesthesia. In a routine ESS, it is a rare event. However, infraorbital nerve becomes susceptible to surgical trauma when running within a mesentery, during assessment or clearance of the roof of the maxillary sinus and during removal the posterior maxillary wall to gain access to the infratemporal fossa. Prevention is achieved by identifying a low-set or exposed nerve in a preoperative CT scan and by minimizing instrumentation along the roof of the sinus.

Management is conservative, even if it is completely transected. Should the nerve stay anatomically intact, the patient should expect a slow return of sensitivity over several months, although paraesthesia may be permanent.

Orbital Injury

Orbital injury can be divided grossly into the extraconal compartment, containing mostly fat, and the intraconal compartment, which contains muscles, the optic nerve and the ocular globe.

Orbital injury is fortunately uncommon, but the risk is increased should the surgeon be disorientated and confused by excessive bleeding, scarring from previous surgery or anatomical abnormalities caused by intraorbital pathology. It is a surgical field where it is so important to maintain good orientation and vision and far better to abandon surgery if this principle cannot be maintained. The usual mechanisms of orbital injury include direct penetration, thermal injury or the use of powered instruments, which have the greatest potential for causing severe, long-lasting sequelae [22].

An ophthalmological assessment is essential in the immediate postoperative scenario, and it is important to instruct the patient not to blow the nose for about 2 weeks following surgery.

Tips

Avoid dissecting with instruments or probes pointing towards the orbit and do not apply pressure on the lamina papyracea. Always keep the tip of the instruments in the visual field. The use of the microdebrider is discouraged during removal of the vertical portion of the uncinate process if located too close to the lamina papyracea.

In the advent of a mild injury without any evidence of damage to the orbital contents, we recommend leaving the area alone and avoiding further exploration of the injury. The surgeon should avoid suction of exposed orbital fat, to avoid trying to replace fat back into the orbit and to avoid the use of coagulation forceps or power instrumentation in the vicinity of the orbital breach.

If in doubt of a perforation of the lamina papyracea, ask the scrub nurse to gently push the eye whilst looking for potential movements of the orbital contents with the endoscope.

Extraocular Muscle Injury

The incidence of extraocular muscle injury is extremely low. The medial rectus muscle is the most common one involved, followed by the inferior rectus muscle.

Prevention is best achieved by a meticulous scrutiny of the CT imaging where a potential dehiscence of the medial orbital wall can be detected, especially in cases with a history of previous surgery. Additional risk factors include facial trauma, sinonasal neoplasm or expansive inflammatory processes.

The immediate management consists of excluding the possibility of severe but reversible complications that could threaten the patient's vision.

Magnetic resonance helps to determine the possible site, extent and pattern of the injury. Re-anastomosis of the muscle, grafting or sutures may be attempted in a second stage.

Orbital Haematoma

The collection of blood inside the orbital space is mainly due to bleeding from the anterior ethmoid artery (Fig. 34.5). Blindness can occur due to a multitude of causes that included increased orbital pressure, stretching of the optic nerve, optic nerve ischaemia, compression of the central retinal artery and other retinal vessels.

Fig. 34.5 Orbital hematoma due to bleeding from the anterior ethmoid artery. Tip: remove packing

It is suggested that to prevent blindness, an orbital haematoma must be treated within 90 min, but this is derived from historical data following animal research that is no longer valid or relevant. In reality, ischaemic damage to the retina is likely to occur within 10 min, but the circumstances and blood supply are so variable that this cannot be standardized. The important message is to act quickly, but not to concede or give up if delay happens, as recovery can still sometimes occur after a significant delay of several hours before surgical decompression.

Clinically, one may observe proptosis, oedema, conjunctival haemorrhage and an afferent pupillary defect. Additional features include orbital pain, diplopia, loss of colour vision (the red colour being the first) and eventually blindness.

Management includes ophthalmological consultation, immediate removal of nasal packing, orbital massage to decrease intraorbital pressure (*caveat: orbital massage is contraindicated in patients with elevated intraocular pressure > 21 mmHG*) and intravenous Mannitol.

Should the orbit feel tense, it is best to perform an immediate lateral canthotomy and cantholysis, ideally under general anaesthesia or local if necessary. This releases the periorbital fascia and allows the orbital contents to protrude anteriorly, thus reducing the intraorbital pressure immediately (Fig. 34.6). This rapidly provides excellent decompression of 14 to 30 mmHg. The procedure is much more effective than endoscopic orbital decompression that requires clearance of the lamina papyracea followed by exposure and incision of the periorbita, allowing orbital fat to herniate into the nasal cavity [23]. However, if there is a significant threat to vision, lateral canthotomy and cantholysis can be combined with medial decompression. Incising the periorbita and releasing orbital fat may optimise the outcome in the event of recurrent bleeding or increasing soft tissue swelling, but is not considered mandatory.

Urgent ophthalmological consultation should be obtained. Tonometry and fundoscopy are helpful in assessing the perfusion to the optic nerve.
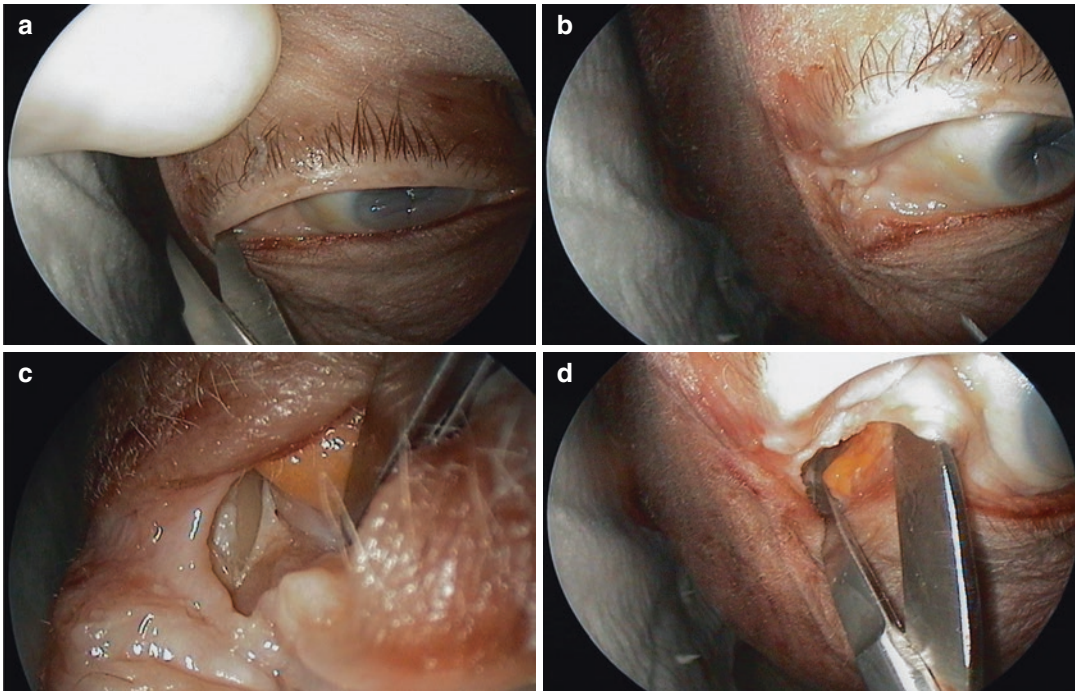
Fig. 34.6 Canthotomy and inferior cantholysis. (**a**) The cornea must always be protected, (**b**) horizontal incision of lateral canthal ligament to the bone, (**c**) incise the peri-osteum on the lateral orbital rim (cygomatic), (**d**) scissors or Freer are used to allow the fat to protrude and lower the pressure on the orbit

Tips

Regular examination of the eyes during ESS is recommended, and thus, the eyes should not be hidden or covered in the surgical field.

Nasolacrimal Duct Injury

Injury to the nasolacrimal duct and subsequent scarring may result in partial or complete obstruction between the nasolacrimal sac or duct and the inferior meatus. Some published reports found injury to the lacrimal duct from 0.62% to 15% depending on the surgical technique [24]. Injury usually occurs when removing the vertical portion of the uncinate process with the backbiter. When injured, the duct should be cut sharply allowing it to heal in a patent configuration. Epiphora as a sequela is rare as the duct tends to heal spontaneously creating a patent drainage system. When detected in the postoperative scenario, a wait-and-see policy is recommended as

epiphora is usually temporarily and will resolve. Should it persist, then endoscopic dacryocysto-rhinostomy is indicated.

Key Learning Points

- The risk of complications is significantly reduced by good preoperative planning, detailed review of imaging at the time of surgery, gentle good technique and attention to anatomy and anatomical variations.
- Most complications are relatively minor and their effects can be minimized by attention to good management.
- Serious complications are fortunately uncommon, but always possible. Should the surgeon inadvertently cause such a complication, they should calmly assess the situation and ensure that they do not make matters worse.
- Causing a serious complication is a stressful experience for a surgeon, and contacting an

experienced colleague to discuss the patient management is strongly recommended.

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