27 Complications of Functional Endoscopic Sinus Surgery

Shanmugam Ganesan, Emad Al Duhirat, Hamad Al Saey, Mansour Al Sulaiti, Maryam Abdulraheem, Rafia Zahid, and Ahmed Shaikh

27.1 Introduction

Functional endoscopic sinus surgery (FESS) is an effective treatment modality for sinus diseases, especially for patients who fail appropriate medical therapy. The outcomes of FESS have improved over time because of multiple factors like technologic advances, improved surgical training, and a better understanding of the disease's pathophysiology. The outcome and complications of surgery are affected by multiple factors, including patient-related factors, pathology, and surgeon-related factors.

The reported complications of FESS are not uncommon. A literature review reveals a range of significant complications between 0.3% and 22.4% (median 7.0%) [1]. The bloody surgical field decreases the visualization and is associated with higher complication rates. It is always safer to abort the procedure and plan elective second surgery if proper hemostasis cannot be achieved. Using image guidance during the surgery decreases the incidence of complications significantly [2]. The global relative ratio of complications on the right side is reported to be 55–86% and found to be more common than the left side [3, 4].

Proper preoperative preparation, including thorough history taking, physical examination, and detailed interpretation of the CT scans, will alert the surgeon to the presence of any anatomical variations, which might increase the chance of damage to any vital structures including the orbit and skull base.

27.2 Increased Risk of Complications

- Revision surgery
- Anatomic variations
- Advanced sinus disease
- Severe comorbidities
- Increased intraoperative bleeding
- Inexperienced surgeon
- Increased risk on the right side (right handed surgeon)
- Extended endoscopic sino-neurosurgery

S. Ganesan (✉) · H. Al Saey · M. Al Sulaiti
Otolaryngology-Head and Neck Surgery Division, Department of Surgery, Hamad Medical Corporation, Doha, Qatar

Department of Otolaryngology-Head and Neck Surgery Division, Weill Cornell Medicine-Qatar, Doha, Qatar
e-mail: sganesan@hamad.qa; Halsaey@hamad.qa; Malsulaiti1@hamad.qa

E. Al Duhirat · M. Abdulraheem · R. Zahid · A. Shaikh
Otolaryngology-Head and Neck Surgery Division, Department of Surgery, Hamad Medical Corporation, Doha, Qatar
e-mail: EAlDuhirat@hamad.qa; mabdulraheem1@hamad.qa; rzahid1@hamad.qa; ashaikh4@hamad.qa

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27.3 Prevention of Complications

- Knowledge, skill, and experience of the surgeon
- Patient checklist prior to surgery, which includes:
  - Sinus-skull base anatomy imaging
  - Maxillary-to-ethmoid sinus ratio
  - Slope of the skull base
  - Cribriform plate/Olfactory cleft
  - Anterior and posterior ethmoidal arteries location
  - Lamina papyracea
  - Optic nerve and carotid artery positions in the sphenoid sinus
  - Presence of Onodi cell
  - Anatomic variations/Asymmetric skull base

Multiple ways were used to categorize the complications of FESS, either to the severity or to location (Table 27.1).

Table 27.1 FESS complications

Localization/ overall type of injury	"Minor complication"	"Major complication"
Orbital complicaton	• Orbital emphysema • Ecchymosis of the eylid	• Orbital hematoma • Reduced visual acuity/blindness • Enophthalmos • Injury of the nasolacrimal duct
Intracranial complication	• Uncomplicated CSF fistula	• CSF leak • (Tension-) pneumocephalus • Encephalocele • Brain abscess • Meningitis • Intracranial (subarachnoid) hemorrhage • Direct injury of brain tissue
Bleeding	• Minor bleeding (stopped with nasal packing, no need for blood transfusion)	• Injury of the ant. ethmoidal artery • Injury of the sphenopalatine artery • Injury of internal carotid artery • Bleeding in need of transfusion
Other	• Synechiae • Slight exacerbation of preexisting bronchial asthma • Hyposmia • Local infection (osteitis) • Postoperative MRSA-Infection • Atrophic rhinitis • Paraffinoma • Myospherulosis • Temporal irritation of the infraorbital nerve • Hypoesthesia of the lip or teeth	• "Toxic shock syndrome" • Anosmia • Severe exacerbation of a preexisting bronchial asthma or bronchospasm • Death

Courtesy of Hosemann et al.: Danger points, complications, and medicolegal aspects in endoscopic sinus surgery [5]

27.4 Intraoperative Complications

27.4.1 Intranasal Complications

Diffuse mucosal bleeding, which affects the operation flow and its safety, occurs mainly in the setting of active inflamed mucosa and nasal polyposis in the absence of proper preoperative and intraoperative preparation. About 5% of the endoscopic sinus surgery is affected by diffuse bleeding, and about 1.4% of the procedures are canceled [6, 7]. The rate of peri- or postoperative bleeding is supposed to be around 2% altogether; transfusion was needed in about 0.2% of cases [8, 9].

- A preoperative systemic steroid (e.g., 30 mg/day prednisone for 5 days) and possibly adding topical cortisone treatment can lead to less bleeding, which reduces the duration of surgery [5].
- Lifting the head and the upper part of the patient's body for about 10–20°.

- Applying local, drug-induced vasoconstriction [10–13].
- Topical vasoconstriction by epinephrine (usually 1:1000) [14]. Optic nerve damage and blindness after the application of pads of adrenaline have been reported [15]. The risk of side effects is 0.05%, and it was concluded that the topical application of epinephrine 1:1000 is safe in adults who have no prior cardiac damage. 0.05% oxymetazoline is used, with subsequent use of 0.1% oxymetazoline for children; in selected cases, epinephrine 1:2000 can be used [16, 17].
- Controlled hypotension by anesthesia.
- 50–60 or 80 mmHg for elderly individuals, and a decrease of the systolic blood pressure less than 100 mmHg [3, 18]. Note, the mean arterial blood pressure must not be decreased to less than 85% of the initial. Also, note that dangerous complications like organ ischemia have been seen in 0.02–0.06% of cases [19, 20, 22].
- Heart rate and blood loss have been shown to have a relationship, and there is a recommendation for a pulse rate of 60 per minute [5].
- The insertion of 3% H_2O_2 using saturated cotton wool strips is recommended to suppress capillary bleeding [23].
- Use of tranexamic acid.
  - Tranexamic acid is applied: perioperative administration (3 × 1 g daily for 5 days, starting 2 h before the operation) is recommended [24].
  - Tranexamic acid (10 mg/kg) is administered intravenously at the beginning of the sinus surgery, leading to a significant improvement of the hemostasis in the surgical area [25].
- Rinsing the surgical field with 40° hot water is also helpful [26].

27.4.2 Arterial Injury

Arterial bleeding sources are the sphenopalatine artery, anterior ethmoid artery, and the posterior ethmoid artery. Knowing their anatomy will help to avoid their injury.

Sphenopalatine artery: In 80%, the sphenopalatine foramen is located in the superior nasal meatus or the transition area between the middle nasal meatus and the superior nasal meatus, directly behind or below the ethmoidal crest of the palatine bone. Several ostia are found in about 13% of cases [27, 28]. In 97% of cases, the SPA is divided into two or more branches. In 64% of cases, 3–10 branches may enter the lateral nasal wall [29, 30]. The nasoseptal branch of the sphenopalatine artery traverses through the lower third of the anterior wall of the sphenoid sinus and the surgeons entering the sphenoid sinus should avoid injury to the vessel. In approximately 3% of pituitary surgery, postoperative bleeding occurs from this vessel [5].

Resection of the middle turbinate near its posterior insertion site along the lateral nasal wall, aggressive enlargement of the maxillary ostium in a posterior direction, and enlargement of the sphenoid ostium in an inferior direction all may cause bleeding from the sphenopalatine artery or one of its branches. Generally bleeding from the sphenopalatine artery is managed by identification of the vessel and its branches and controlled by clipping or electrocautery methods (Fig. 27.1).

The anterior ethmoid artery: Cadaveric studies showed variability of the location of the anterior ethmoid artery. The distance from nostrils to the anterior ethmoid artery at the skull base is approximately 6–7 cm, and the distance to the

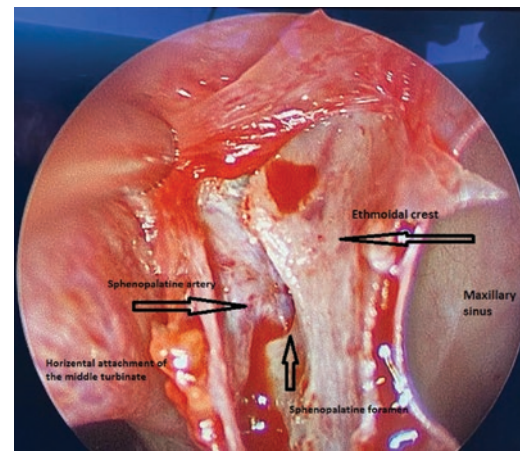

Fig. 27.1 Sphenopalatine artery

posterior ethmoid artery is approximately 7–8 cm [31–33].

The artery could be identified endoscopically within the posterior wall of the most superior suprabullar ethmoidal cell and approximately 11 mm posterior to the common wall between the posterior wall of the frontal infundibulum and this superior-most suprabullar cell [31–35]. According to anatomical studies, arteries are missing in about 5–10% of cases. The anterior ethmoid artery traverses the skull base around 12 mm anterior to the posterior ethmoid artery (Figs. 27.2, 27.3, and 27.4).

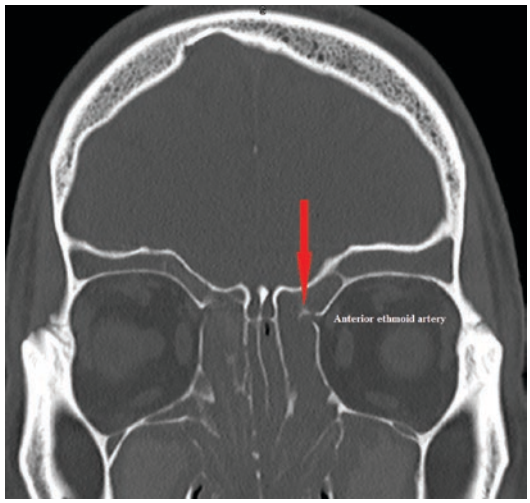

Fig. 27.2 Anterior ethmoid artery

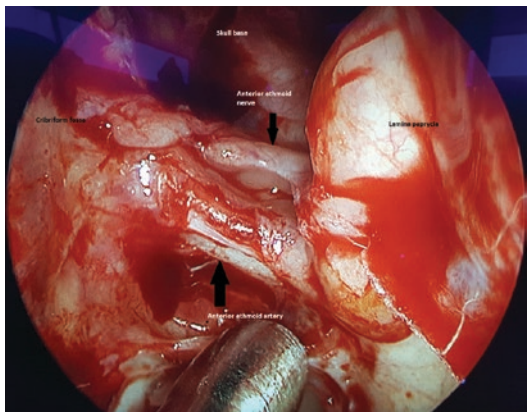

Fig. 27.3 Anatomical dissection of the anterior ethmoid artery

Since the blood flows through the anterior ethmoid artery from a postero-lateral to an antero-medial direction, the angle between the lamina papyracea to the artery is 60° and its disruption must be managed to avoid retraction of the artery into the orbit. Bipolar cautery is preferred to control the bleeding, to avoid transmitting the electrical current to the skull base and orbit. The external approach can also be used for control.

The posterior ethmoid artery: It runs 5 mm anterior to the sphenoethmoid angle, which is formed by the junction of the anterior sphenoid wall and the posterior ethmoid roof. It is smaller than the anterior ethmoidal arteries, runs symmetrical and linear in most cases with bony dehiscences noted in approximately 60% of cases. The distance to the optic nerve is 8–9 mm. According to literature, absence of arteries is noted in 2–34% of cases. The artery is most commonly injured during sphenoid sinus entry or during manipulations of the posterior ethmoid bone [5]. Bipolar cautery is preferred to control the bleeding, to avoid transmitting the electrical current to the skull base and orbit (Fig. 27.5).

27.4.3 Intraorbital Complications

The most common orbital complication of the endoscopic sinus surgery is a trauma of the lamina papyracea [36]. The incidence of a periorbital injury is around 2% [6, 8].

27.4.4 Orbital Emphysema

Postoperative emphysema of the eyelid may occur following nose-blowing, sneezing, or after anesthesia with mask ventilation. In several cases, there have been two likely observations—either a surgical defect or a history of fracture in lamina papyracea.

Mainly, in the upper eyelid, the emphysema develops. Orbital emphysema usually managed conservatively and resorbed within a week. Nose-blowing and sneezing are advised to the patient to be avoided (Fig. 27.6) [38, 39].

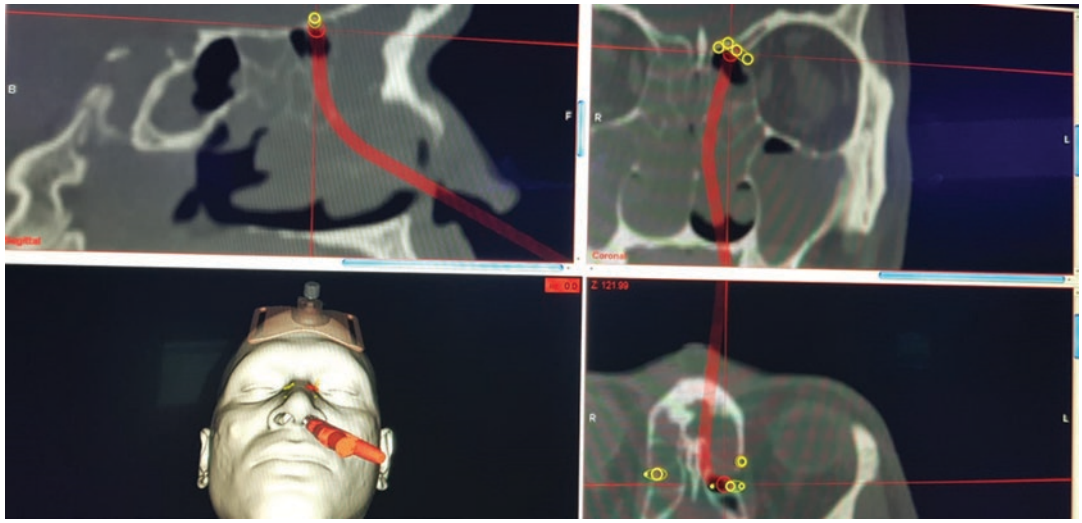

Fig. 27.4 Navigation assisted localization of the anterior ethmoid artery

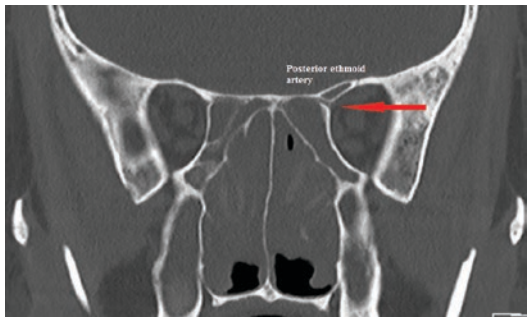

Fig. 27.5 Posterior ethmoid artery

Fig. 27.6 Orbital emphysema due to injury to lamina papyracea. (Courtesy of Kevin C. Welch, MD, James N. Palmer, MD Department of Otorhinolaryngology, Division of Rhinology, University of Pennsylvania [37])

27.4.5 Orbital Fat Exposure

Injury to the lamina papyracea may occur during uncinectomy, or aggressive lateral dissection during ethmoidectomy. The injury most likely occurs due to aggressive debrider powered instrumentation or in the presence of hypoplastic-atelectatic maxillary sinus.

Routine palpation of the globe is vital while operating in this region, watching for any movement by performing intraoperative pressure test described by Draf and Stankiewicz [5]. In case orbital fat is seen, manipulation of the fat within the ethmoid sinus should be avoided to prevent further injury. Uses of suction manipulation and powered instrumentation should be avoided. No repair of this defect is needed. If needed, a silicon sheet can be placed temporarily on the area of the defect. Serial examinations of the eye should be performed during the remainder of surgery to ensure that intraorbital hemorrhage has not developed. Nasal packing should usually be avoided in such cases (Fig. 27.7).

27.4.6 Intraorbital Hematoma

The incidence of orbital hematoma is around 0.1% [40, 41]. The average orbital volume in a confined cavity is 26 cc and an increase in vol-

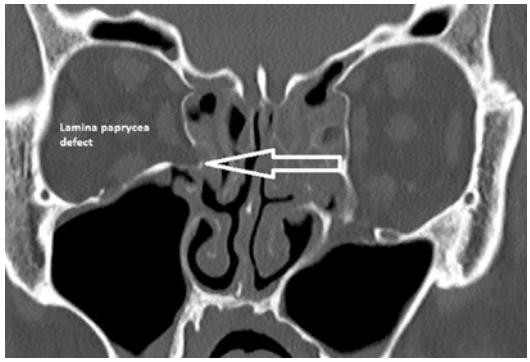

Fig. 27.7 Right orbital content prolapse

Fig. 27.8 Orbital hematoma as a result of anterior ethmoid artery injury. (Courtesy of Kevin C. Welch, MD, James N. Palmer, MD Department of Otorhinolaryngology, Division of Rhinology, University of Pennsylvania [37])

ume of 4 cc results in 6 mm proptosis. Normal intraocular pressure is 12–22 mmHg.

Intraorbital hemorrhage has 50% the risk of permanent blindness with manifest retrobulbar hematoma with accompanying loss of vision [37, 41, 42]. Bleeding into the orbit occurs from injury to intraorbital vessels or retraction of a bleeding from anterior or posterior ethmoid arteries causing an acute increase in the intraorbital pressure and retinal ischemia. Injury to orbital or ophthalmic veins results in slow process of accumulation of blood. The retina can tolerate up to 90 min of ischemia before irreversible damage happens (Fig. 27.8).

Signs and symptoms of intraorbital hemorrhage include:

- Tense globe
- Increased intraocular pressure
- Progressive proptosis with chemosis
- Conjunctival vessels congestion and subconjunctival hemorrhage
- Pupillary dilation
- Loss of pupillary reflex
- Eye pain
- Limitation of eye mobility
- Visual field loss and loss of vision

The list of managing a slowly expanding intraorbital hematoma and proptosis occurring mainly in the postoperative period, most likely secondary to venous bleeding includes the following:

- Head end of the bed raised
- Cooling compresses applied
- Removal of nasal packing if any
- Gentle eye massage applied provided if there is no contraindication
- Administration of systemic steroids (dexamethasone 0.2 mg/kg IV)
- Mannitol 20% (1–2 g/kg IV over 20–30 min)
- Acetazolamide (10–15 mg/kg IV) can reduce edema and aqueous humor production
- Topical Timolol eye drops 0.5%, 1–2 drops twice daily, can help reduce intraocular pressure through decreasing the production of aqueous humor
- Antibiotics
- Immediate ophthalmic consultation with a serial examination of visual acuity and intraocular pressures is mandatory [37]
- CT scan

A rapidly developing intraorbital hematoma occurring either intraoperatively or in the recovery room, most likely secondary to anterior ethmoidal injury is managed as follows [5].

- Stop the procedure if it happens during surgery
- Elevate the head end of the bed
- Cooling compresses applied with ice
- Normalize the blood pressure
- Remove nasal packing
- Control nasal bleeding if any
- Consult the ophthalmologist
- Ocular massage helps to redistribution of hematoma (controversial)

A lateral canthotomy (reduction of IOP by approximately 14 mmHg) and cantholysis (reduction of IOP by approximately 30 mmHg) must be performed to increase orbital volume and reduce the pressure [37]:

- Intraocular pressure more than 40 mmHg
- Loss of pupillary reflex
- Cherry red macula

Additional following procedures can be performed if needed:

- Medial orbital wall decompression (reduction of IOP by approximately 10 mmHg)
- Orbital floor decompression
- Control of bleeding by endoscopic or external artery ligation (Fig. 27.9)

Flowchart algorithm (Fig. 27.10):

27.4.7 Extraocular Muscle Injury

The medial rectus muscle is the most susceptible muscle to injury during endoscopic sinus surgery, especially in the posterior ethmoid sinus resulting in irreversible diplopia and exotropia. It is likely to occur with an incidence of approximately 1/1000 [35]. Other eye muscles are less often injured; the inferior rectus muscle may be damaged in surgeries involving the maxillary sinus, and the superior oblique (trochlea) muscle may be lacerated in extended endonasal frontal sinus surgery [43].

The use of powered instruments (microdebrider) in sinus surgery has been associated with greater risks of injury to the extraocular muscles [44]. Injuries may range from muscle contusion to complete transection. Strabismus surgery is not always successful in restoring the full range of motion of the globe, but if any surgery to be

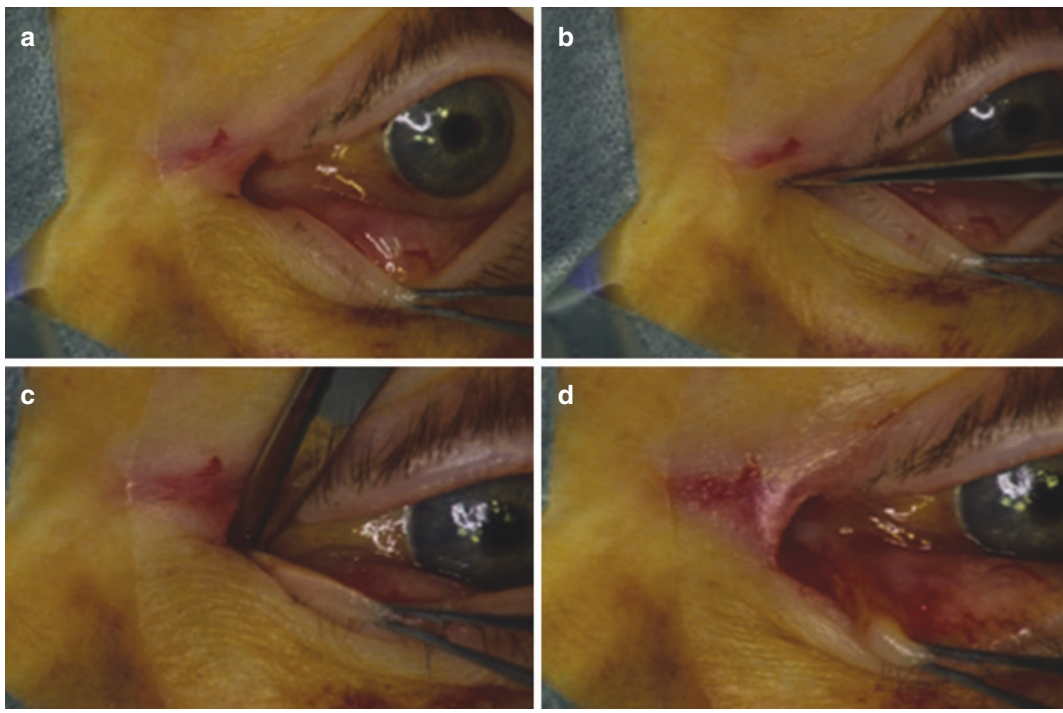

Fig. 27.9 Steps of lateral canthotomy and cantholysis. (**a**) Lateral canthus incision. (**b**) Retraction of the inferior lid shows the extent of incision. (**c**) The inferior crus of the lateral canthal tendon is divided. (**d**) The lower lid is retracted to show the final result. (Courtesy of R. Gausas, MD, Philadelphia, PA [37])

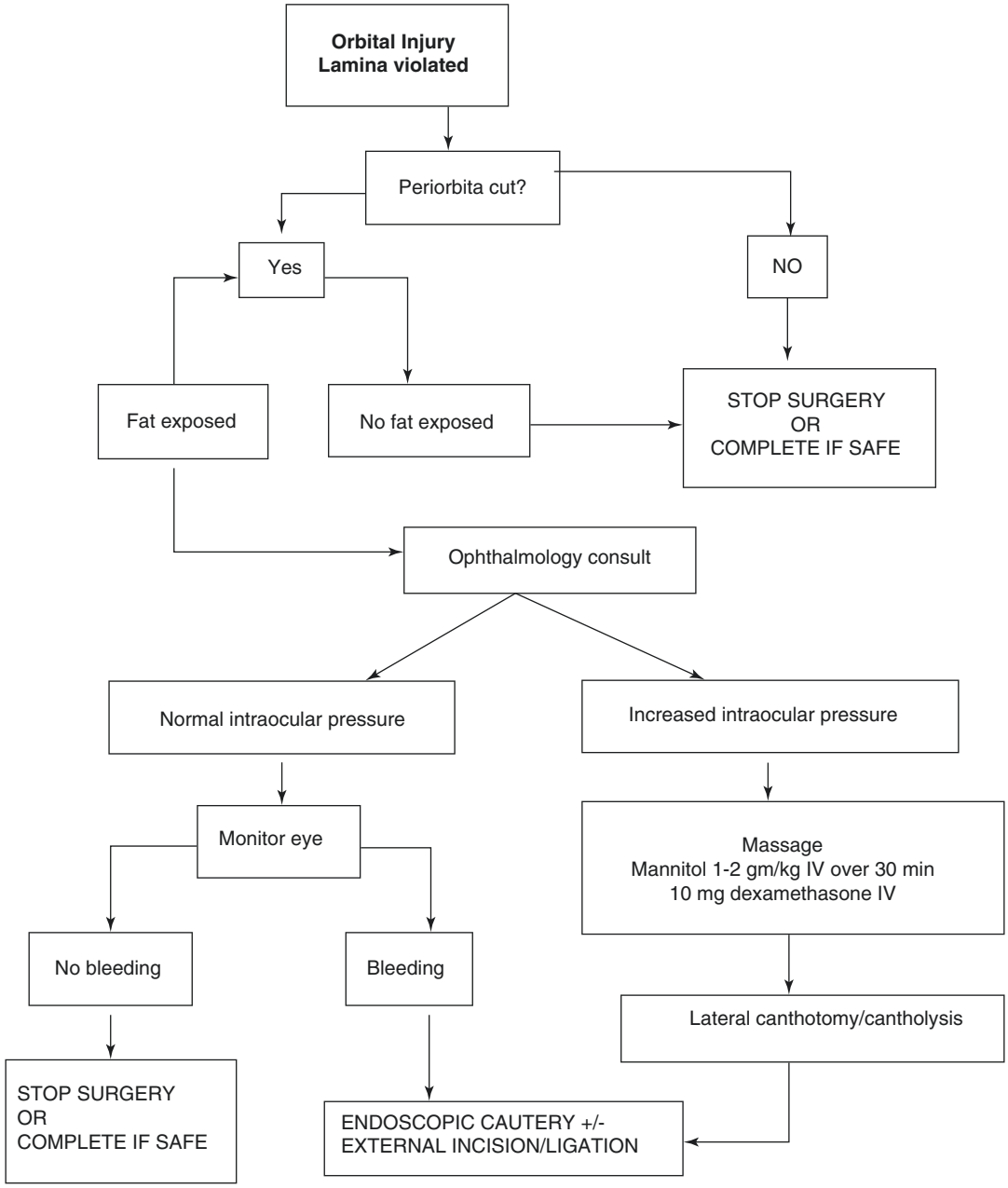

Fig. 27.10 Algorithm for addressing intraoperative orbital bleeding. (Courtesy of Kevin C. Welch, MD, James N. Palmer, MD Department of Otorhinolaryngology, Division of Rhinology, University of Pennsylvania [37])

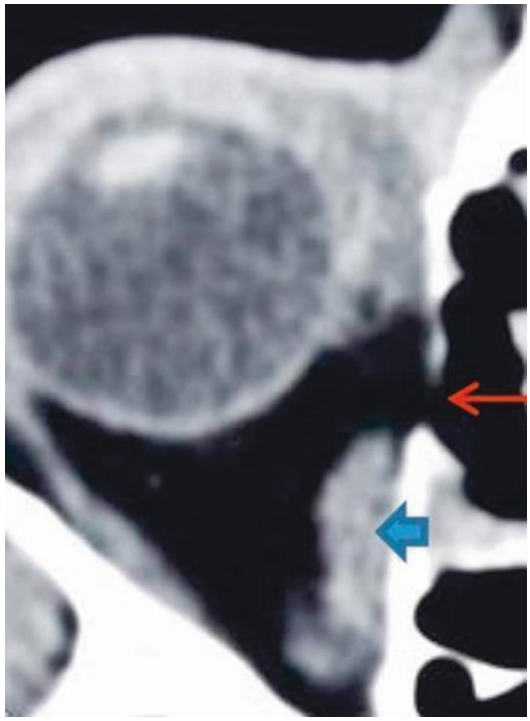

Fig. 27.11 Postoperative CT scan showing the destruction of the lamina papyracea (red arrow) and complete transection of the medial rectus muscle (blue arrow). (Courtesy of Hosemann et al.: Danger points, complications, and medicolegal aspects in endoscopic sinus surgery [5])

done should be performed within 2–3 weeks from injury after the resolution of the edema (Fig. 27.11).

27.4.8 Optic Nerve Injury

The optic nerve typically forms an indentation in the lateral wall of the sphenoid sinus, and approximately 5% of these have dehiscent bone; this can occur unilaterally or bilaterally. Failing to recognize the Onodi cell can place patients at risk for optic nerve injury during a posterior ethmoidectomy. Onodi cells present in 8–14% of the general population and considered to be a posterior ethmoid cell that pneumatizes lateral and superior to the sphenoid sinus [45].

Optic nerve injury can happen at the level of the orbital apex or the superolateral sphenoid sinus, which might cause a partial loss of vision or blindness.

If an injury to the optic nerve is suspected,

- Normalize the blood pressure
- A high-dose systemic corticosteroid (dexamethasone 0.5–1 mg/kg body weight IV) should be given
- Administration of methylprednisolone 4 × 250 mg per day for 3 days (controversial)
- Ophthalmologic consultation to assess the visual acuity
- A postoperative CT scan is necessary to evaluate the location and extent of this injury
- MRI scan helps to evaluate the optic nerve sheath or disruption
- Optic nerve decompression in specific cases may be considered (Fig. 27.12)

27.4.9 Intracranial Complications

All suspected and proven intracranial complications must be managed jointly with the neurosurgery team.

A pneumocephalus is the presence of gas (air) in the cranial cavity. Largely, it is based on the extracranial and intracranial space communication. In subdural, epidural, intraventricular, subarachnoid, or intracerebral spaces, air may be present.

Intracranial pressure increases gradually, causing a tension pneumocephalus to develop.

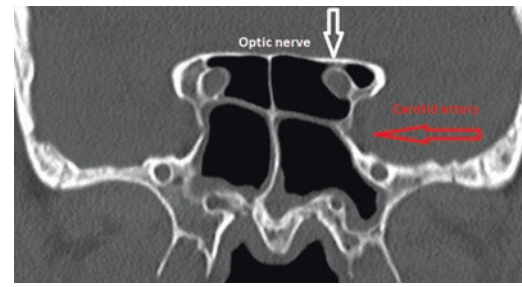

Fig. 27.12 CT scan coronal section showing the optic nerve (dehiscent) within the sphenoid sinus (white arrow), carotid artery bulging inside the sphenoid sinus (red arrow)

Symptoms include:

- An altered state of consciousness.
- Restlessness.
- Headache.
- Nausea and vomiting.
- Eye motility disorders.
- Ataxia.
- Spasms (Fig. 27.13).

27.4.10 Cerebrospinal Fluid Leak

The incidence of iatrogenic endoscopic sinus surgery injury to the skull base and CSF leak is 0.5% [10, 44]. The rate of unexpected dura exposure is 0.2% [5].

Although the injury may occur anywhere along the skull base, the cribriform plate, posterior wall of the frontal sinus, roof of the posterior ethmoid, and roof of the sphenoid sinus are the most common areas. The weakest area of the skull base and most liable to injury is at the junction of the anterior ethmoid artery and the middle turbinate along the anterior ethmoid roof [46]. The weakest area of the skull base at the lateral lamella of the olfactory fossa is 0.05–1 mm thin and is susceptible for injury. The surgeons should be aware of the asymmetric skull base and the incidence is approximately 10% [5].

Fig. 27.13 Axial CT scan showing tension pneumocephalus post sinus surgery complicated by skull base perforation (Mount Fuji sign). (Courtesy of Hosemann et al.: Danger points, complications, and medicolegal aspects in endoscopic sinus surgery [5])

If the injury is recognized during surgery, better to be managed in the same setting and if managed properly, greater than 90% possibility of a good outcome [47, 48].

Once the patient is awake, a CT scan should be obtained to assess for pneumocephalus or intracranial injury.

Although many surgeons believe that antibiotics cover should be used either oral or intravenous in case of skull base injury and CSF leak, a meta-analysis by Brodie and colleagues showed no significant differences in the rates of ascending meningitis in patients treated with and without antibiotics in traumatic anterior skull base CSF leaks [49].

Bernal-Sprekelsen and colleagues found an incidence of ascending meningitis in 29% of patients treated conservatively [50]. Furthermore, trans-nasal endoscopic repair of CSF leaks has been reported to be successful in 90% to 97% of patients [47, 51].

Literature evidence showed various successful techniques described either underlay or onlay, depending on the size of the defect for repairing the fistula. In general, autologous grafts are preferred which includes mucosa, fascia, fat, cartilage, bone, or perichondrium with or without pedicled flaps. Defects more than 5 mm in diameter are closely in several layers partly with cartilage or bone. Fibrin glue does not need to be routinely applied in every case [5]. In cases where the site of leak is difficult to localize, 10% intrathecal fluorescein (FDA non-approved product) can be used to identify the leak. Appropriate informed consent must be obtained for using fluorescein. Most surgeons prefer nasal packing for 3–7 days with bed rest, antibiotics as a prophylaxis to prevent ascending infection, sleep with head end elevation (40–70°), to avoid lifting heavy objects and blowing nose for a certain period. In addition, patients are advised to sneeze with an open mouth and laxatives are prescribed for patients with constipation. Lumbar drains are not routinely placed except in cases with increased intracranial pressure, large defect repair and revision cases (Fig. 27.14).

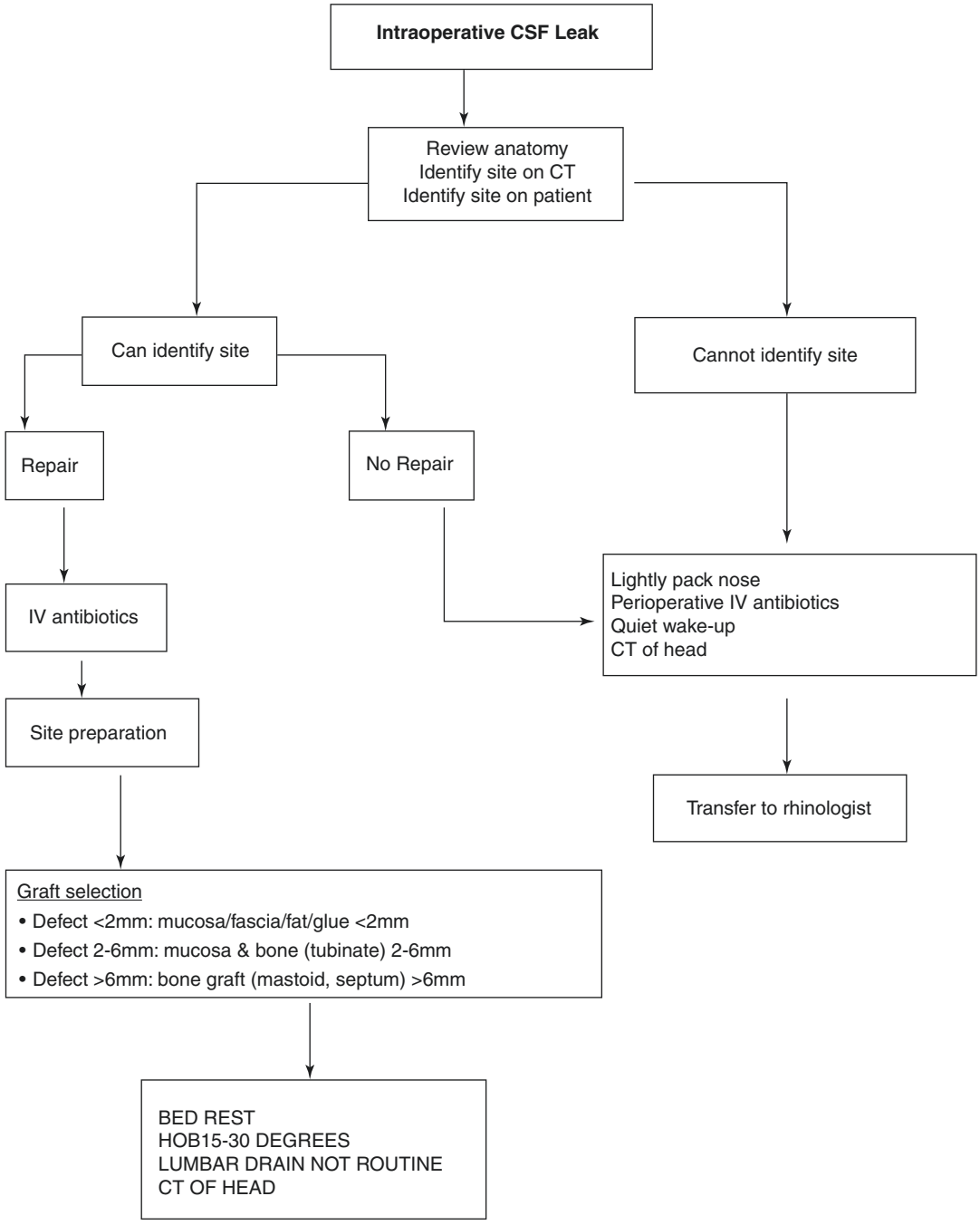

Fig. 27.14 Algorithm for addressing intraoperative CSF leak. (Courtesy of Kevin C. Welch, MD, James N. Palmer, MD Department of Otorhinolaryngology, Division of Rhinology, University of Pennsylvania [37])

27.4.11 Internal Carotid Artery Injury

Exact incidence of carotid artery injuries in paranasal surgery is unknown. Review of literature has shown a rate of 0.3% in surgery of diffuse chronic rhinosinusitis [8]. A rate of 1% for pituitary surgery [52]. For sinoneurosurgical procedures, the rate quoted is approximately 0.3–0.9%. Mortality rate is 17% [5].

The internal carotid artery (ICA) indents the lateral sphenoid sinus wall, with 7% of these being dehiscent. 1% of inter-sphenoid septum will insert on the bony canal of the carotid artery [37].

Injury to the ICA may occur when the sphenoid sinus is entered too far laterally, or the carotid canal is penetrated when surgical dissection is performed along the lateral sphenoid wall, and the carotid canal is penetrated (Fig. 27.15).

Internal carotid artery injury management plan:

- Immediate tight nasal packing and pharyngeal packing to tamponade the bleeding
- Several suctions and multiple IV lines must be established
- Initiate aggressive fluid resuscitation, and emergency blood transfusion should begin to maintain cerebral perfusion
- Maintain normotension
- Compression of same side of ICA with or without cervical incision
- Consult and involve neurosurgery team help
- Definitive treatment is performed by the interventional radiologist, who uses angiography to identify the site and extent of vascular injury (Fig. 27.16)

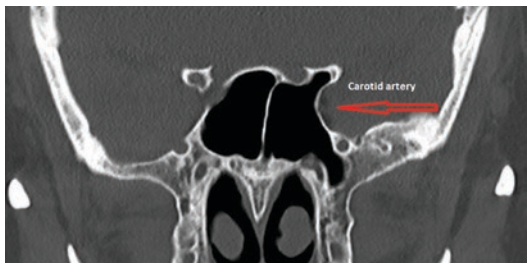

Fig. 27.15 CT scan coronal section showing the carotid artery relation to the lateral wall

27.5 Postoperative Complications

27.5.1 Intranasal Complications

27.5.1.1 Epistaxis

The prevalence of epistaxis following sinus surgery is 2% [8].

It is typically seen either immediately following surgery because of inadequate hemostasis or 5–7 days after surgery when the crusts get dislodged.

In cases where excessive bleeding is absent at the end of surgery, nasal packing should not be placed at the end of surgery [53, 54] as packing materials may cause delayed restoration of normal sinus drainage and increased patient discomfort. Mild cases of postoperative epistaxis can often be managed with topical decongestant sprays.

Epistaxis treatment protocols use a stepwise treatment approach based on the severity and site of bleeding.

- Vital signs monitoring
- Blood tests for Hg level and coagulation profile
- Intravenous access for fluid replacement and blood/blood products transfusion if needed
- Identify the site of bleeding and try to cauterize if bleeding source is identified
- Packing with absorbable or non-absorbable nasal packs may be needed
- Bleeding that is not controlled with conservative measures, examination under anesthesia must be performed and cauterization or ligation of vessels should be performed
- Embolization or external ligation in case of failure of the previous methods must be discussed as the available options

27.5.1.2 Sinusitis

The possibility of sinusitis after sinus surgery is high and reaches up to 16% of patients [29]. Bare mucosal surfaces, intranasal bacterial colonization, and decreased mucociliary clearance of nasal secretions contribute to sinus infection during the healing period.

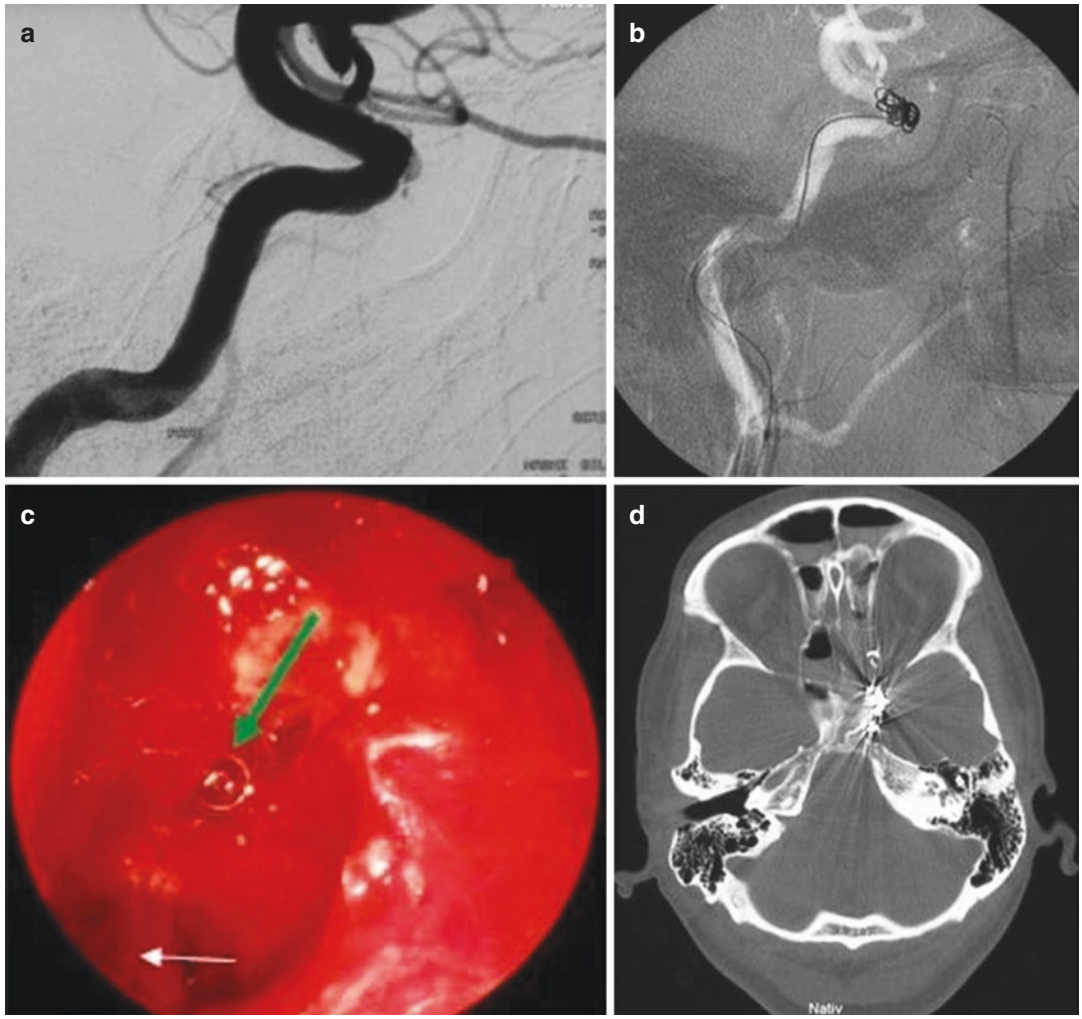

Fig. 27.16 Laceration of the left-sided internal carotid as a complication of sinus surgery. (**a**) Angiogram locating the lesion site (Anterior genu). (**b**) Occlusion of the artery by coils. (**c**) Revision surgery shows the coil. (**d**) Post-treatment CT scan. (Courtesy of Hosemann et al.: Danger points, complications, and medicolegal aspects in endoscopic sinus surgery [5])

27.5.1.3 Synechiae

The most common complication of sinus surgery is synechia formation. Synechiae occur in about 10% of cases, however, in most cases (60–90%) functionally unapparent [7, 8, 55]. One to three percent of incidence of symptomatic synechiae are documented [3, 56].

In a series of patients undergoing revision sinus surgery, adhesions were found to be present in 56% of cases and were felt to be a contributing factor for failure in up to 31% of patients [57].

In case of trauma to the middle turbinate mucosa, an adhesion may form between the middle turbinate and the lateral nasal wall, obstructing sinus drainage pathways. Adhesions may also form between the inferior turbinate and the nasal septum. The generally acknowledged postoperative basic care consists of rinsing with saline and mechanical cleaning, and topical steroids are essential for synechia formation avoidance [58]. Non-absorbable/absorbable nasal packing can help to avoid synechiae. Specific placeholders have been developed with the same intention.

After an ethmoidectomy, in 10–40% of cases, scar-induced lateralization of a detached vertical lamella of the middle turbinate is noted. A lateral synechia may occur in the area of the medial orbital wall in up to 7% of cases [59].

Literature has shown many recommendations to prevent scar-induced lateralization of a "floppy turbinate," also known as a conserved, mobile vertical lamella of the middle nasal turbinate. Such recommendations are shown below:

- Special supporting septum foils (splints) for about 14 days.
- Establishing a small, "controlled synechia" to the nasal septum, possibly using fibrin glue. Olfactory impairment was not observed.
- Suturing of the middle turbinate to the nasal septum. An olfactory impairment was not observed.
- By using a branch, the fixation of the lamella using customary clips introduces an artificial pouch in the mucous membrane of the septum. Using an absorbable clip in the mucous membrane of the septum in which the lamella of the turbinate is pinned can create a similar effect. This clip consists of polylactides.
- Absorbable, cortisone-releasing stents may be inserted into the ethmoid (Fig. 27.17).

Myospherulosis is a foreign body reaction to petrolatum or lanolin found in some antibiotic ointments used to coat packing material placed in the nose, which might result in granulation tissue formation. This complication may be avoided by the use of water-soluble antibiotic gels, instead of petrolatum-containing ointments, in patients undergoing sinonasal surgery [60].

27.5.1.4 Anosmia

Postoperative anosmia in about 0.07–1% of endoscopic sinus surgery [8]. In rhinoneurosurgical surgery, the rate of postoperative anosmia is approximately 2% [61].

27.5.1.5 Hyposmia

Postoperative deficits in smell may occur secondary to scarring of olfactory mucosa, direct mechanical trauma, progressive inflammation of the olfactory cleft mucosa, and modification of the nasal air flow passage. Hosemann et al. quoted in their article that the rate of postoperative hyposmia is about 3% and the rate of smell distortion is around 9% [5]. It is imperative to document any complaints related to smell and taste preoperatively for medicolegal purpose.

27.5.1.6 Secondary Atrophic Rhinitis

Secondary atrophic rhinitis may occur after extensive sinus surgery or revision multiple sinus

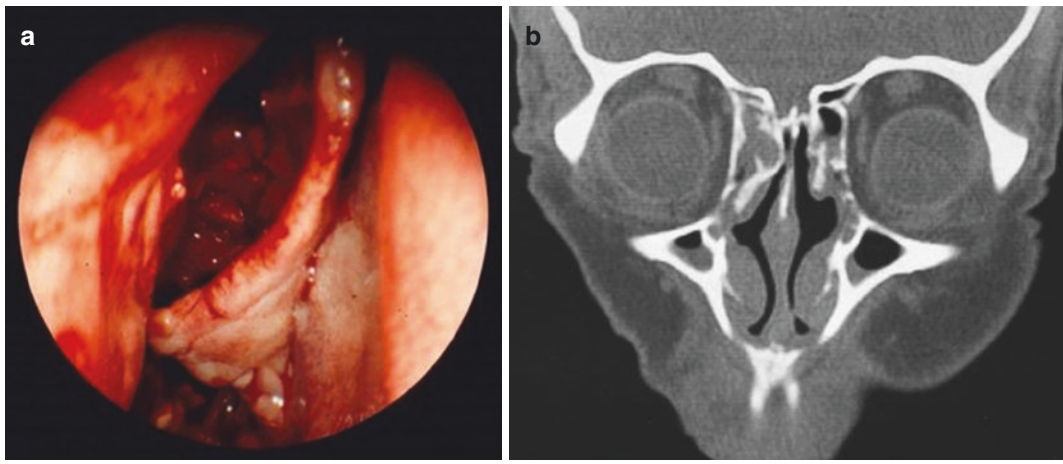

Fig. 27.17 (**a**) Intraoperative floppy turbinate. (**b**) CT scan shows the lateralization of the middle turbinate. (Courtesy of Hosemann et al.: Danger points, complications, and medicolegal aspects in endoscopic sinus surgery [5])

surgeries, due to stripping of larger areas of mucous membranes and resections of both middle and superior turbinates. Patients usually complain of nasal obstruction in the presence of roomy wide nasal cavities and excessive accumulation of crusting noted on endoscopic examination. In general, the rate of postoperative atrophic rhinitis after routine CRS surgery is roughly between 0.08% and 0.4% [5].

27.5.2 Orbital Complications

27.5.2.1 Corneal Abrasion

Keeping the eyes exposed during the endoscopic sinus surgery to serve as a landmark and to check for orbital complications is an essential part of the draping method for sinus surgery; nevertheless, this might expose the eye for trauma or dryness.

Corneal abrasion presents with eye pain and foreign body sensation during the immediate postoperative period. Ophthalmology consultation should be done.

27.5.2.2 Nasolacrimal Duct System Injury

The surgeons should be familiar with the nasolacrimal duct system to avoid complications. The lacrimal sac is approximately 7 mm wide and extends 4–8 mm cranially beyond the axilla of the middle turbinate. The distance between the free edge of the uncinate process and the anterior edge of the lacrimal sac is 5 mm (0–9 mm) and the maxillary sinus optimum is approximately 4 mm (0.5–18 mm) [5].

Epiphora following endoscopic sinus surgery has been reported by experienced surgeons between 0.3% and 1.7% of cases. In 3% of cases, inadvertently injuries of the lacrimal ducts are described [40].

Injury to the nasolacrimal duct can occur while enlarging the maxillary ostium too far anteriorly using microdebrider or back-biting forceps, uncinectomy, and surgery on the anterior frontal recess.

Nasolacrimal duct injury symptoms appear directly after surgery or within 2–3 weeks. Patients present with persistent tearing (epiphora) or lacrimal sac infection (dacryocystitis) [62]. All patients need closure follow-up and ophthalmology consultation if needed. Persistent symptomatic patients need dacryocystorhinostomy.

27.5.3 Intracranial Complications

27.5.3.1 Cerebrospinal Fluid Leak

Persistent, unilateral, and watery rhinorrhea following sinus surgery may alert for CSF leak. A CT scan is needed to evaluate the integrity of the skull base, looking for the presence of a bony defect or pneumocephalus, and a sample of nasal fluid should be collected for beta-2 transferrin assay.

27.5.3.2 Meningitis

Postoperative meningitis is rare, although it represents the most frequent intracranial complication in paranasal sinus surgery. In rhino-neurosurgical procedures, the postoperative rate of meningitis is about 1–3% [63, 64].

When suspecting meningitis, a CT scan has to be ordered immediately, followed by a lumbar puncture. Symptoms or findings are, e.g., fever, laboratory diagnostics indicating major inflammation, headache and neck pain, and impaired consciousness. An active cerebrospinal fluid fistula needs to be detected, and the patient should also be monitored intensively [65].

Rarely (0.9%), a frontal brain abscess was reported after rhino-neurosurgical surgery. Mainly responsible are *Staphylococcus aureus*, gram-negative bacteria, or polymicrobial colonization.

Most studies imply that the prophylactic administration of antibiotics does not reduce the risk of meningitis or brain abscess in skull base surgery [66]. When antibiotics are used in routine cases, the following antibiotics are recommended as monotherapy: ceftazidime, amoxicillin/clavulanic acid, or cefazolin. Vancomycin or clindamycin are recommended if there is intolerance [67, 68].

27.6 Revision Surgery

Despite the progress in the FESS techniques and the technological advances, 10–15% of the patients will undergo revision surgery [21, 69, 70]. Major complications after revision FESS rate was 0.46% and was found to be similar to primary cases [1].

Take Home Messages

- The best management of complications is avoidance, and in order to avoid complications, surgeons should have good anatomical knowledge.
- Study preoperative imaging thoroughly.
- Training in hands-on cadaveric dissection courses.
- It is always safer to abort the procedure and plan elective second surgery if proper hemostasis cannot be achieved.
- Informed consent and documentation for medicolegal purpose.
- Remember learning curve.
- Know your limitations and call for help.
- The percentage of significant complications between 0.3% and 22.4% (median 7.0%).
- The most common complication of sinus surgery is synechiae formation.
- The most common orbital complication of the endoscopic sinus surgery is a trauma of the lamina papyracea.
- Meningitis is the most frequent intracranial complication in paranasal sinus surgery.

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