Surgery for Nasal Polyposis

28

Joseph Brunworth and Peter John Wormald

Key Take-Home Points

- Although nasal polyposis in the setting of chronic rhinosinusitis (CRS) is a challenging disease process due to its higher rate of disease recurrence, research suggests that a few key surgical decisions and a more aggressive approach may help decrease the return of symptoms and rate of polyp recurrence [1–3].
- Even though a functional approach may be appropriate for straightforward osteomeatal complex obstruction and can be addressed with limited surgery (uncinectomy, maxillary antrostomy, restoration of adequate ventilation) [4, 5], a subset of patients including asthmatics and patients with eosinophilia, chronic rhinosinusitis with nasal polyposis, fungal sinusitis, a narrow frontal recess, and Samter's triad will require more extensive surgery [1].
- The mixture of polyps and mucin within the sinuses harbors large numbers of activated eosinophils and contributes to disease load. If these are not removed and persist within the sinuses, the capacity for rapid disease recurrence remains, and another exposure of the activating antigen can result in reactivation of the inflammatory cascade and result in significant disease recurrence.

J. Brunworth, MD
Department of Otolaryngology, St. Louis University Hospital,
6th Floor, Desloge Towers, 3635 Vista Avenue, St. Louis, MO 63110, USA
e-mail: brunworth@slu.edu

P.J. Wormald, FRACS, FCS(SA), FRCS(Ed), MD (✉)
Department of Otolaryngology – Head and Neck Surgery, University of Adelaide,
The Queen Elizabeth Hospital, 28 Woodville Road, Woodville, SA 5011, Australia
e-mail: peterj.wormald@adelaide.edu.au

P.S. Batra, J.K. Han (eds.), *Practical Medical and Surgical Management of Chronic Rhinosinusitis*, DOI 10.1007/978-3-319-16724-4_28

- The rate of polyp recurrence has been shown to be additive with the number of predisposing factors for recurrence [1] (e.g., a patient with a narrow anterior-posterior (AP) frontal diameter, a history of asthma, eosinophilic allergic fungal sinusitis, *plus* aspirin sensitivity). It is in these patients with multiple risk factors that the modified endoscopic Lothrop/Draf III procedure is an option to decrease the chance for polyp recurrence and the need for further surgery [1, 6].
- At this point in time, it is not currently recommended to perform primary frontal drill-outs on patients who have not had prior standard functional endoscopic sinus surgery (ESS). The current recommendation is to counsel patients with multiple predisposing factors about their increased chance of requiring future surgery, including the potential need for a frontal drill-out procedure.

Introduction

Nasal polyposis is a common disease that has a prevalence of 1–4 % of the population [7–9]. The pathogenesis of nasal polyps is poorly understood [10–13]. This distinctive disease process is now known to affect more than just primates, affecting other animals such as cats and even koalas [14, 15]. The nasal mucosa can exhibit a spectrum of disease ranging from edematous to polypoid to frank polyps, thus contributing to the difficulty in the research of this disease process [16, 17].

Surgery for nasal polyposis is perhaps one of the most challenging yet rewarding procedures performed by the otolaryngologist. Surgical difficulty is amplified by the increased rate of bleeding encountered during surgery, the thinning of the lamina papyracea due to expansion from the polyps, the obstructed view of the frontal recess during its dissection, and the propensity for polyps to distort anatomy near vital neurological and vascular structures [18]. However, the immediate relief of nasal obstruction with a high level of appreciation and increased quality of life found in most patients postoperatively accounts for the rewarding aspect of this surgery [19, 20].

The severity of nasal polyposis varies vastly from patient to patient. Although several attempts have been made to categorize polyps, their variability makes classification and grading a challenge [21]. The mucosa can exhibit a spectrum of disease ranging from edematous to true polyps even within the same nasal cavity. In addition, postoperative changes often mimic polyps in the initial healing phase after sinus surgery. In our research, we found it is important to differentiate between those who exhibited recurrent polyps that resolved on medical treatment and medically resistant recurrent polyps, because the latter group had a higher risk of ultimately requiring further surgical intervention [2].

Once a patient has been diagnosed with nasal polyps and other disease processes have been ruled out, a systematic investigation into the pathogenesis of the patient's

disease is undertaken. A standard workup should include a complete history with a focus on past medical history (seasonal allergies, sinusitis, asthma, aspirin or nonsteroidal anti-inflammatory [NSAID] sensitivity), sinus symptoms, family history (primary ciliary dyskinesia, cystic fibrosis, etc.), social history (smoking, environmental exposures), and prior therapies. Blood tests can help elucidate patients with high concentrations of eosinophils. Patient-specific allergens can be detected via immunoassay tests. Patients found to have specific allergens may benefit from additional skin allergy testing for higher sensitivity and specificity.

After a complete workup, a patient should be given options for his or her choice of treatment. In general, a trial of medical therapy is attempted prior to the decision to proceed with surgery. A portion of patients with minimal polyp disease will respond to medical therapy alone, while others may respond to surgery alone or surgery with continued medical therapy. Due to the fact that the pathogenesis of polyp disease is still incompletely known, it is important to counsel patients in regard to the long-term therapy for nasal polyposis and to dispel the preconceived notion that a single surgery will be curative.

Surgical Anatomy

In most patients with nasal polyposis, the nasal cavity is either partially or completely filled with polyps (Fig. 28.1). After decongestion and infiltration of the lateral nasal wall, the polyps are removed to reveal the underlying anatomy. A microdebrider is used to remove all the polypoid tissue from the middle turbinate with preservation of the turbinate itself. In previously unoperated patients, polyps from the middle meatus are debrided to expose the underlying uncinate and bulla

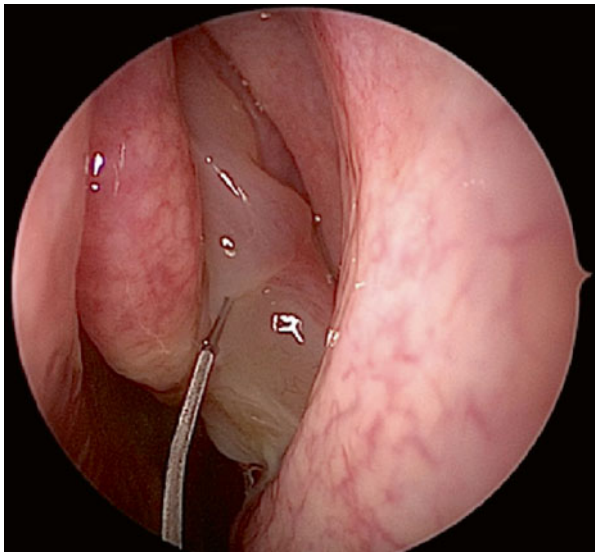

Fig. 28.1 Left nasal cavity showing polyp filling the middle meatus. In this revision case, residual uncinate is seen lateral to the polyp and must be addressed

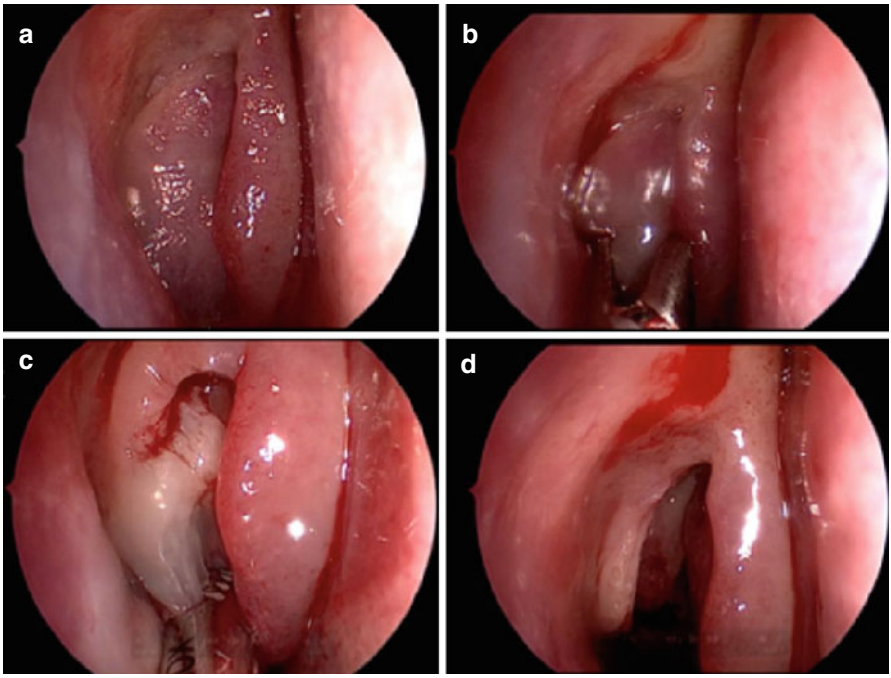

Fig. 28.2 Progression of surgery for polyps. (**a**) Polyps in the middle meatus. (**b**) Representative piece taken for histology. (**c**) Microdebrider usage. (**d**) Exposed uncinate and bulla ethmoidalis. The remainder of the surgery is carried out in the same manner as non-polyp patients

ethmoidalis (Fig. 28.2). The surgery is now conducted as if the patient did not have polyps and the anatomy is dealt with in the same way as patients without polyps. In patients who have had previous surgery, normal anatomical landmarks are often absent or obscured and surgery is conducted by first finding the most consistent landmarks. In these cases, the safest method is to start posteriorly and proceed along the skull base into the frontal sinus. First, the polyps are debrided and the middle turbinate or its remnant is identified. Next the posterior choanae are identified and the debrider is moved up the anterior face of the sphenoid until the sphenoid ostium is widely opened. This is continued superiorly until the skull base is identified (Fig. 28.3). Next, the skull base is followed anteriorly to the region of the anterior ethmoidal artery and the frontal ostium is identified and the entire skull base and lamina papyracea are cleared (Fig. 28.4).

In patients who have not previously undergone surgery, the easiest way to understand the anatomy of the frontal drainage pathway is to perform a careful analysis of the CT scans, identify each individual cell, and place them in their anatomical location so that a 3D conceptualization of the anatomy is achieved [18]. In general, cells that lie anterior to the drainage pathway are considered frontal ethmoidal cells, starting with the most anterior ethmoid air cell, the agger nasi. Cells posterior to the drainage pathway are typically suprabullar cells, and if they extend into the frontal sinus, they are denoted as frontal bullar cells.

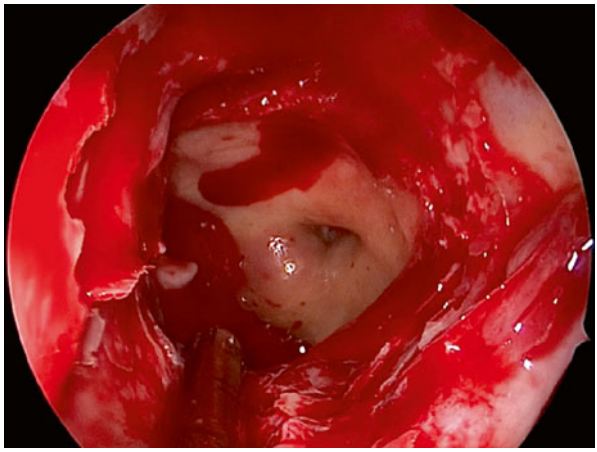

Fig. 28.3 Wide left sphenoidotomy showing the optico-carotid recess posterolaterally, skull base superiorly, and orbit laterally

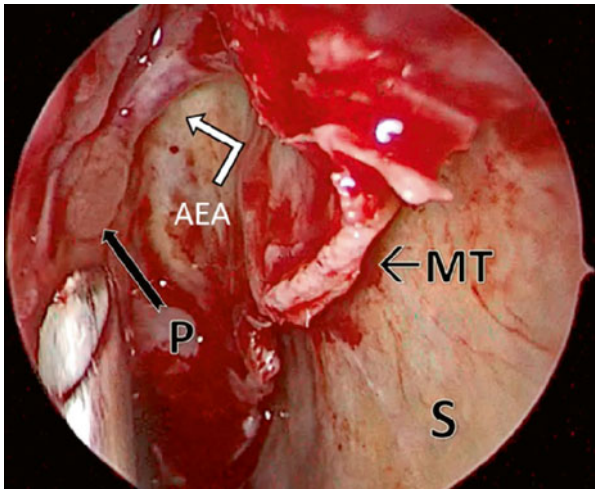

Fig. 28.4 Revision ESS for polyps requiring an aggressive approach. Picture shows the suction curette approaching the polypoid tissue (*P*) near the anterior ethmoidal artery (*AEA*) that lies on a mesentery along the skull base. This case required a frontal drill-out as well as trimming of the middle turbinate (*MT*). The septum (*S*) is marked for reference

Upon passing the axilla of the middle turbinate, the most commonly encountered drainage pathway is located posterior and medial to the agger nasi/frontal ethmoid cells. However, certain predisposing factors may cause the drainage pathway to run anterior or lateral such as an intersinus septal cell. In the case of polyps, the bony divisions on the preoperative CT scan can be difficult to discern and must be looked at with caution.

Indications

Indications to proceed with surgery for nasal polyposis are largely dependent on patient symptoms, the two most common symptoms being nasal airway obstruction and loss of the sense of smell. Other symptoms may include allergic symptoms (sneezing, ocular/nasal pruritus, rhinorrhea, etc.), recurrent bouts of sinusitis

(colored nasal discharge, fevers, facial pain, etc.), or even a change in voice due to decreased resonance in the nasal airway. It is important to discuss the chronic nature of the disease with the patient. Although many of the symptoms that affect the patient may be improved by surgery, patients need to know the limitations of surgery. For example, nasal allergic symptoms and reactions to environmental triggers usually require ongoing medical management after surgery.

Although symptoms of polyp disease are often quite specific, there are some important exceptions to consider when working up a patient with polyps. Any patient with unilateral polyp disease should be biopsied to rule out papilloma, other benign tumors, or malignancy. Any suspicious lesion on endoscopy, a lesion that has a tendency to bleed, a polyp that does not respond to steroids, any expansile lesion seen clinically or radiographically, and especially any nasal mass that appears erosive or invasive also warrant a biopsy. If the clinical picture suggests a highly vascular tumor or an encephalocele, in-office biopsies are avoided and further workup is performed.

Once a patient is diagnosed with nasal polyps, a trial of maximal medical therapy is typically warranted prior to considering surgery. However, it has been increasingly recognized that patients with massive nasal polyps will have only short-term temporary relief [22], and the risks and benefits of offering a course of systemic steroids versus going straight to surgery need to be discussed with the patient. Initial treatment of polyps is often successful in reducing patient symptoms, but the frustration lies in the tendency for polyps to recur. Although systemic steroids are effective in reducing the size of polyps and improving symptoms, these medications have significant side effects, especially with long-term use. Recent research has looked at the risk-benefit of repeated steroid usage and found that the risks of steroid use start to outweigh the benefits once the steroids are used more than twice a year [23]. The most essential consideration in all patients is the importance of discussing the risks, benefits, and alternatives to the surgery so that expectations are fully anticipated and aligned with realistic goals.

Preoperative CT scans where surgery for nasal polyposis is to be performed are essential. However, the universal use of image guidance during polyp surgery is not an absolute and generally varies according to surgeon preference and image-guidance availability. Patients whose biopsy results show anything other than typical inflammatory polyposis will generally require an MRI and further workup prior to surgery, and their treatment will vary depending on the diagnosis.

Surgical Technique

For many centuries, nasal polyps have been written about, and records reflect the various attempts that have been made to eradicate them [24]. In the 1970s Messerklinger introduced the concept of nasal endoscopy [25, 26] followed by Stammberger's adaptation in the 1980s, popularizing a more functional approach to the sinuses [27–29]. Stammberger's technique is based on limited tissue resection with the aim of reestablishing the natural drainage pathways of the sinuses. It has

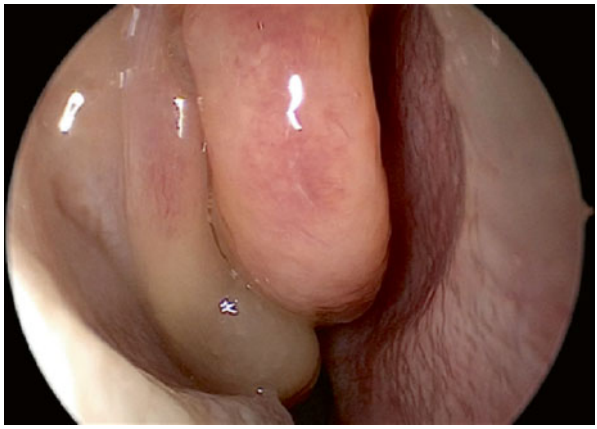

Fig. 28.5 Caution must be taken in polyp cases as the anatomy may initially be distorted. In this right nasal cavity, the uncinate process is retroflexed as well as polypoid

been shown to be effective in CRS patients but appears to be less effective in patients with a high disease load. In this patient group, usually defined as a Lund and MacKay score of more than 12 out of 24, a more radical approach has been shown to be more effective in reducing polyp recurrence. Inflammatory disease load is comprised of polyps and surrounding mucus. It is often thick, tenacious, and difficult to clear from the sinuses. The polyps have activated eosinophils that, if remain after surgery, quickly reactivate the inflammatory cascade and result in disease recurrence. The mucus, in turn, has bacteria often in the form of biofilms and may have superantigen producing *Staphylococcus aureus*. In subgroups of polyp patients, fungal elements promote inflammatory stimulation of the mucosa. These patients exhibit a high incidence of disease recurrence should the fungal mucus not be removed at the time of surgery.

Upon commencing surgery, the initial step is to take a representative polyp from each side and send this for histology. The microdebrider is then used to remove the intranasal polyps and delineate the middle turbinate and the uncinate process. Due to tendency of nasal polyps to compress nearby structures, the uncinate process is carefully assessed as it may be paper-thin and plastered against the orbit or it may be retroflexed upon itself (Fig. 28.5). A sickle knife is used to cut the upper region of the uncinate while a backbiter frees the inferior portion and a "swing-door" technique is used to finish the uncinectomy (a ball probe is used to fracture the uncinate forward; then a 45° through-biting forceps is used to remove the mobilized uncinate flush with its insertion on the frontal process of the maxilla).

Once an uncinectomy has been preformed, a 30° scope with a curved suction and right-angled ball probe is used to identify the natural ostium of the maxillary sinus. The ostium is enlarged into the posterior fontanelle and a 70° scope is used to assess the sinus for disease. In the author's hands, a fully diseased maxillary sinus with polyps throughout the sinus is best approached with a canine fossa trephination rather than a mega antrostomy in order to reach the anterior medial and lateral walls of the sinus. This allows for an efficient and thorough clearance of the maxillary sinus with effective, long-standing postoperative results [30]. The incidence of lip

and teeth numbness if the correct landmarks are used for this procedure is around 3 % after 6 months. The landmark for canine fossa trephine is the mid-pupillary line and the floor of the nose.

The approach to the frontal sinus varies from surgeon to surgeon. In a previously unoperated patient, utilizing the axillary flap through the front face of the agger nasi cell allows a direct approach with good visualization while still predominately using the zero degree endoscope. Once the agger nasi and frontal ethmoidal cells have been removed, the pathway to the frontal sinus is cleared using a combination of angled instruments (giraffes, frontal punches, angled microdebriders, etc.) and angled scopes. All polyps are removed, the mucosa is trimmed but not stripped, and all partitions of the frontal recess are removed to ensure the maximal aperture of the frontal sinus.

Next the bulla ethmoidalis is opened and polyps are removed. The orbital wall is delineated with all partitions and polypoid mucosa trimmed down until flush with the lamina papyracea. Again, frequent palpation of the globe and careful attention is paid to the fact that the already thin lamina may be dehiscent in the case of polyps. The middle turbinate basal lamella is then opened medially at the junction of the horizontal and vertical portions of the lamella. An additional landmark is the level of the maxillary roof. The posterior ethmoids are visualized along with the superior turbinate, which will be in a medial and superior position. The inferior third of the superior turbinate is removed, thus exposing the sphenoid sinus natural ostium. Often polyps will need to be removed from the posterior nasal cavity inferior to the superior turbinate and even medial to the middle turbinate. Caution is taken to avoid the cribriform plate any time while working medially and superior in the nose. Next the sphenoid sinus is opened widely from the skull base to the level of the posterior septal artery. If the artery is transected, then suction cautery is used to achieve hemostasis. Polyps are removed from within the sphenoid sinus; powered instrumentation use is avoided within the sphenoid sinus near the optic nerve or internal carotid artery.

Traversing along the skull base from the sphenoid sinus toward the frontal sinus, the final partitions of the ethmoidal complex are removed, leaving mucosa on the roof while ensuring that all cells are open and the polyps are trimmed down to within approximately 1–2 mm of the bone. Caution is taken to identify and avoid the anterior ethmoidal artery should it be on a mesentery (Fig. 28.4) and therefore at risk for transection. The frontal recess and frontal ostium are again checked and cleared of any remaining polypoid tissue with maximization of the frontal ostium.

In patients in whom polyps recur, this is usually first seen in the frontal ostium/recess before the polyps and then spreads to the ethmoids. Why the recurrences start in this region and whether the narrow frontal ostial region predisposes to polyp formation are still unclear. In patients who have had a complete ESS with clearance of all polyps and ostia and who develop a recurrence, a modified Lothrop/Draf III or frontal drill-out may be required. This starts with complete clearance of all the other sinuses and a trimming of the lower half of the middle turbinate. This creates a much improved ventilation and topical therapy access to the posterior

ethmoids and sphenoid region. Next the frontal drill-out is done. This creates a large common frontal ostium and allows effective topical application of steroids in the postoperative period. It improves the ventilation to the frontal region and, in a survey of outcomes from our department [2], has proved to be highly effective in reducing the incidence of polyp recurrence postoperatively. The frontal drill-out starts with a septal window with the posterior margin of the window formed by the anterior ends of the middle turbinates. The lower border of the window should allow an instrument to be passed from one side of the nose across the septum and under the axilla of the middle turbinate on the opposite side. The anterior margin is taken anteriorly until the frontal process of the maxilla anterior to the uncinate can be seen with an endoscope passed through the septal window via the opposite nostril. The upper rim of the window is taken onto the roof of the nose. Next, the frontal sinus mini-trephines are placed and fluorescein-stained saline is injected into the frontal sinuses so that the fluorescein can be seen draining through the natural frontal sinus ostium. This gives the surgeon the posterior landmark for the surgery. The drill is always kept anterior to the fluorescein. Drilling starts on the frontal process of the maxilla and progresses laterally until the skin is exposed giving the surgeon the lateral landmark. Drilling proceeds superiorly (not medially) until the floor of the frontal sinus is opened. This is done bilaterally; then the first olfactory neuron is identified determining the anterior projection of the skull base. This is confirmed with image guidance. The intersinus septum is taken down and the frontal "T" drilled back onto the skull base. An angled bur is used to take the superior edge of the neo-ostium away until the anterior wall of the frontal sinus runs smoothly out into the nose (Fig. 28.6).

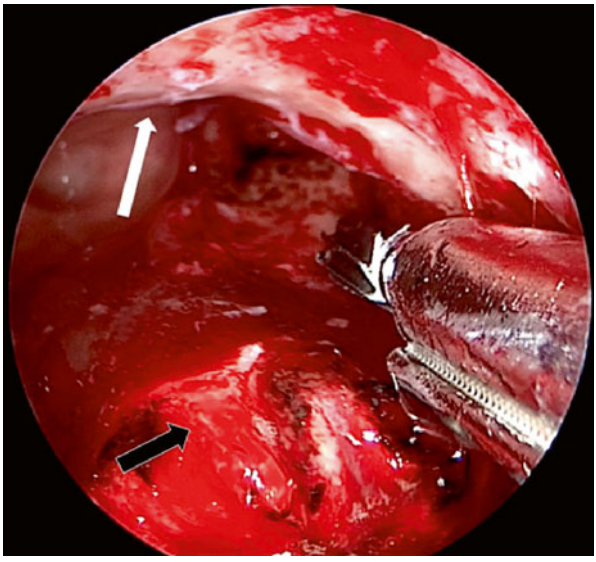

Fig. 28.6 Frontal drill-out being performed utilizing a high-speed 3 mm angled bur to ensure the frontal sinus drains smoothly into the nose (*white arrow*). The maximum anterior-posterior (AP) diameter is achieved by drilling the frontal "T" (*black arrow*) down to the anterior projection of the cribriform plate

In a study looking specifically at the recurrence rate of polyps after frontal sinus drill-out (Draf III) procedure compared to standard ESS with a Draf IIa frontal sinusotomy, the Draf III patients required significantly less revision surgeries [2]. This was even more evident in asthma and aspirin-intolerant patients. The overall revision rate was 18 % (follow-up duration >12 months, median = 29 months), with a 37 % revision rate in the ESS group versus 7 % in the Draf III group ($P < .001$). Survival analysis showed that the Draf III significantly reduced the risk of revision (hazard ratio = 0.258, $P = .0026$). We postulate that the more aggressive surgical approach to nasal polyps tends to maximize ostia size, clear the sinuses of the inflammatory load, and allow postoperative topical medications to reach all aspects of the sinuses and therefore reduce the incidence of polyp recurrence.

Complications

Before discussing iatrogenic complications of surgery for polyp disease, a brief overview of the possible complications that can arise from the polyps themselves is warranted and should also be discussed with patients. Left untreated, polyps have a wide range of natural growth patterns. In rare cases, polyps may resolve spontaneously. In other cases, polyps might grow to a certain size and remain stable; symptoms such as nasal blockage, rhinorrhea, postnasal drip, and hyposmia/anosmia may persist. However, in cases of more aggressive polyposis, more serious complications may arise. Firstly, polyps may grow large enough to block sinus outflow pathways and promote bacterial and fungal growth, thus leading to infectious sinusitis. Obstruction of sinus ostia may lead to mucocele formation with subsequent erosion of the orbit and/or skull base. Secondly, polyps may enlarge enough to cause complete bilateral nasal airway obstruction and even protrude from the nostrils. Lastly, benign nasal polyposis may also exhibit an aggressive growth pattern causing orbital violation or penetration into the skull base.

Alternatives to surgery should be discussed with patients as well. The most efficacious oral medications for treating nasal polyps, corticosteroids [31, 32], are fraught with side effects and occasionally cause permanent sequelae [33, 34]. Probably the most worrisome complication with enduring ramifications from corticosteroid usage is avascular necrosis of the hip joint. Although this has a known risk of 9–40 % when long-term therapy is needed, avascular necrosis is limited to case reports when used in 0.5 mg/kg doses for short-term treatment (less than 3 weeks) and is primarily found after intravenous usage [35–37]. In fact, in a survey by Madanagopal et al. of over 600 orthopedic physicians prescribing oral steroids, no cases of avascular necrosis were reported over a 2-year period [38]. Regardless, a brief discussion of the risks of steroids, antibiotics, or other medications used for treating nasal polyp patients should be included during the office visit. Considering the tendency for polyps to recur, a multimodality treatment approach is often necessary, and reviewing the risks and benefits of each therapy becomes essential (Table 28.1).

Despite a large percentage of patients having a temporary response to medical therapy, many will require surgery due to persistence of nasal polyposis.

Table 28.1 Risks of surgery, corticosteroids, or no intervention for nasal polyps

Surgery	Corticosteroids	No intervention
Visual impairment	Psychosis	Continued nasal obstruction
Blindness	Insomnia	Worsening of nasal obstruction
Vascular injury	Mood swings	Anosmia
Death	Nightmares	Orbital extension
CSF leak	Reflux/gastric ulcers	Intracranial extension
Meningitis	Weight gain	Sinus obstruction/infection
Anosmia	Moon facies/buffalo hump	Protrusion of polyps from nose
Epiphora	Avascular hip necrosis	
Need for further surgery	Increased blood sugars	
Synechiae	Immunosuppression	
Return of polyps	Cataract development	
	Temporary relief only	

Table 28.2 Important predisposing risk factors for more common complications seen during surgery for nasal polyps [39, 55]

Complication	Predisposing factors
Violation of lamina papyracea (2 %)	Maxillary sinus hypoplasia (4 %) Ethmoid sinus hypoplasia (10 %) Laterally positioned natural ostium of maxillary sinus Dehiscence of lamina (0.5 %)
Bleeding (5 %)	History of bleeding disorder or tendency to bleed easily Pharmacological effects (i.e., platelet inhibitors, vitamin K antagonists, nonsteroidal anti-inflammatories, herbal medications) Polyp disease
Skull base violation (0.2–0.8 %)	Low riding ethmoid roof Asymmetry of ethmoid roof Deep cribriform plate Thin skull base bone density

Because of the tendency for polyps to distort nasal anatomy, utmost precaution must be taken during surgery for nasal polyposis. Although major complications are rare, their consequences can be permanent, devastating, and even lethal.

The types of complications encountered during surgery for nasal polyposis are analogous to those seen during other endoscopic sinus surgeries and have been written about extensively [39–45]. Bleeding may be as simple as a minor ooze during the surgery, can substantiate a blood transfusion, or can be as devastating as a carotid injury [46–48]. Orbital complications range from exposure of orbital fat exposure to blindness or permanent diplopia [49–52]. Intracranial penetration may entail an intraoperative repair of a CSF leak or can lead to extensive postoperative intracranial complications [53, 54].

In their review from 2013, Hosemann and Draf [39] quoted an overall minor complication rate of 5 % and major complication rate of 0.5–1 % during all routine endoscopic interventions. Certain predisposing factors may result in increased risk of particular complications (Table 28.2).

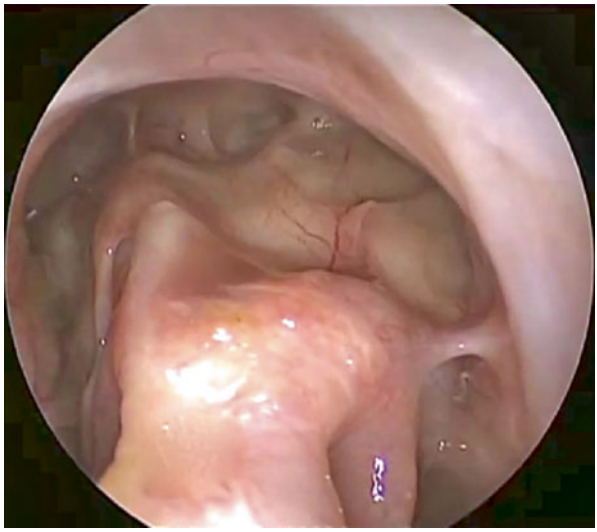

Fig. 28.7 Postoperative view of the frontal sinus 9 months after an endoscopic frontal drill-out for recurrent nasal polyps has been performed

Clinical Efficacy Data

The short- and long-term clinical efficacy of sinus surgery for adult chronic rhinosinusitis with and without nasal polyposis has been demonstrated in multiple reviews of the literature. Poetker et al. showed that significant improvements in patient-reported symptoms, quality-of-life surveys, endoscopy scores, medication use, and financial impact were found consistently throughout the literature across multiple institutions [56]. The data for nasal polyp surgery also shows significant improvements across multiple subjective and objective measures [19, 20, 57]. However, it is also well established that the recurrence rate for polyps is significantly higher than other forms of sinusitis, especially in the patients mentioned above with Samter's triad or similar predisposing conditions [58, 59]. In our review of 338 consecutive polyp patients [2], the incidence of a polyp recurring in the total cohort of all patients who were followed up for >12 months was 44.3 %. The incidence of polyp recurrence that persisted despite medical treatment for at least 3 months or more was significantly less, with 19.8 % in those followed up 6 months or longer and 22.7 % for those followed up 12 months or longer. When comparing the rate of polyp recurrence after standard ESS plus a Draf IIa (49 %) versus a Draf III procedure (36 %), the rate was found to be significantly less in those patients who underwent the Draf III (49 % vs 36 %). It is apparent that, although surgery for nasal polyposis is considered "non-curative" [60], the reduction of disease load in these patients appears to significantly affect the rate of recurrence and revision surgery (Fig. 28.7).

Conclusion

Surgery for nasal polyposis has proven to be an effective tool for improving patient symptoms as well as various other objective measures of success.

However, it does not always offer a cure for this chronic condition and many patients require multiple operations as well as continuation of additional treatment modalities. Patients that have a higher risk for recurrence include those with asthma, aspirin sensitivity, allergic fungal sinusitis, eosinophilia, narrowed frontal ostia (provided the polyp disease affects this region), or any combination of these factors. In these patients with a high likelihood of failure, a more aggressive surgery with complete clearance of all partitions from the sphenoid to the frontal outflow path, wide antrostomies, removal of all polyps, and trimming of the polypoid tissue to reduce inflammatory load has shown to improve results.

Sinus surgery, as an adjunct to medical therapy and allergy control or desensitization, has the potential to significantly improve the quality of life in patients with nasal polyposis. This is counterbalanced by the risks incurred during any of the aforementioned treatment options, and a thorough discussion is required with each patient in order to ensure patient understanding.

Considering the tendency for polyps to promote the harboring of bacteria, mucin, fungus, and eosinophils, we conclude that the wide clearance of sinus wall partitions and concurrent clearance of the polypoid tissue are of utmost importance. A total sphenoethmoidectomy, wide maxillary antrostomy (with canine fossa trephination when necessary), and wide access frontal clearance (Draf IIa) are performed as an initial procedure for polyp patients with subsequent Draf III reserved for revision cases with persistent polyp disease and symptoms. In this manner we can most efficiently provide access for delivery of postoperative topical medications and reduce the risk of polyp recurrence.

References

1. Naidoo Y, Bassiouni A, Keen M, Wormald PJ. Risk factors and outcomes for primary, revision, and modified Lothrop (Draf III) frontal sinus surgery. Int Forum Allergy Rhinol. 2013;3(5):412–7.
2. Bassiouni A, Wormald PJ. Role of frontal sinus surgery in nasal polyp recurrence. Laryngoscope. 2013;123(1):36–41.
3. Bassiouni A, Naidoo Y, Wormald PJ. When FESS fails: the inflammatory load hypothesis in refractory chronic rhinosinusitis. Laryngoscope. 2012;122(2):460–6.
4. Stammberger H. Nasal and paranasal sinus endoscopy. A diagnostic and surgical approach to recurrent sinusitis. Endoscopy. 1986;18(6):213–8.
5. Stammberger H. Surgical treatment of nasal polyps: past, present, and future. Allergy. 1999;54 Suppl 53:7–11.
6. Gross WE, Gross CW, Becker D, Moore D, Phillips D. Modified transnasal endoscopic Lothrop procedure as an alternative to frontal sinus obliteration. Otolaryngol Head Neck Surg. 1995;113:427–34.
7. Settipane RA, Peters AT, Chiu AG. Chapter 6: Nasal polyps. Am J Rhinol Allergy. 2013;27 Suppl 1:S20–5.
8. Chaaban MR, Walsh EM, Woodworth BA. Epidemiology and differential diagnosis of nasal polyps. Am J Rhinol Allergy. 2013;27(6):473–8.
9. Rajguru R. Nasal polyposis: current trends. Indian J Otolaryngol Head Neck Surg. 2014;66 Suppl 1:16–21.
10. Bernstein JM, Gorfien J, Noble B. Role of allergy in nasal polyposis: a review. Otolaryngol Head Neck Surg. 1995;113(6):724–32.

11. Tos M, Sasaki Y, Ohnishi M, Larsen P, Drake-Lee AB. Fireside conference 2. Pathogenesis of nasal polyps. Rhinol Suppl. 1992;14:181–5.
12. Casale M, Pappacena M, Potena M, Vesperini E, Ciglia G, Mladina R, Dianzani C, Degener AM, Salvinelli F. Nasal polyposis: from pathogenesis to treatment, an update. Inflamm Allergy Drug Targets. 2011;10(3):158–63.
13. Van Cauwenberge P, Gevaert P, Van Hoecke H, Van Zele T, Bachert C. New insights into the pathology of nasal polyposis: the role of superantigens and IgE. Verh K Acad Geneeskd Belg. 2005;67(1):5–28; discussion 29–32.
14. Galler A, Shibly S, Bilek A, Hirt R. Chronic diseases of the nose and nasal sinuses in cats: a retrospective study. Schweiz Arch Tierheilkd. 2012;154(5):209–16.
15. Bercier M, Wynne J, Klause S, Stadler CK, Gorow A, Pye GW. Nasal mass removal in the koala (Phascolarctos cinereus). J Zoo Wildl Med. 2012;43(4):898–908.
16. Rizk HG, Ferguson BJ. Categorizing nasal polyps by severity and controller therapy. Arch Otolaryngol Head Neck Surg. 2012;138(9):846–53.
17. Czerny MS, Namin A, Gratton MA, Antisdel JL. Histopathological and clinical analysis of chronic rhinosinusitis by subtype. Int Forum Allergy Rhinol. 2014;4:463–9.
18. Wormald PJ. Endoscopic sinus surgery – anatomy, three-dimensional reconstruction, and surgical technique. 3rd ed. New York: Thieme; 2012.
19. Khademi B, Gandomi B, Tarzi M, Yeganeh F. Quality of life, pulmonary spirometry, and dosage of steroid in asthmatic patients with polyposis after endoscopic sinus surgery. Iran J Otorhinolaryngol. 2013;25(71):103–6.
20. Dufour X, Bedier A, Ferrie JC, Gohler C, Klossek JM. Diffuse nasal polyposis and endonasal endoscopic surgery: long-term results, a 65-case study. Laryngoscope. 2004;114(11):1982–7.
21. Durr ML, Pletcher SD, Goldberg AN, Murr AH. A novel sinonasal endoscopy scoring system: the discharge, inflammation, and polyps/edema (DIP) score. Int Forum Allergy Rhinol. 2013;3(1):66–72.
22. Van Zele T, Gevaert P, Holtappels G, Beule A, Wormald PJ, Mayr S, Hens G, Hellings P, Ebbens FA, Fokkens W, Van Cauwenberge P, Bachert C. Oral steroids and doxycycline: two different approaches to treat nasal polyps. J Allergy Clin Immunol. 2010;125(5): 1069–1076.e4.
23. Leung RM, Dinnie K, Smith TL. When do the risks of repeated courses of corticosteroids exceed the risks of surgery? Int Forum Allergy Rhinol. 2014;4:871–6.
24. Wright J. History of laryngology and rhinology. St Louis: Lea and Febiger; 1893. p. 57–9.
25. Messerklinger W. Endoscopy of the nose. Monatsschr Ohrenheilkd Laryngorhinol. 1970;104(10):451–6.
26. Messerklinger W. Techniques and possibilities of nasal endoscopy. HNO. 1972;20(5):133–5.
27. Stammberger H. Endoscopic endonasal surgery–concepts in treatment of recurring rhinosinusitis. Part I. Anatomic and pathophysiologic considerations. Otolaryngol Head Neck Surg. 1986;94(2):143–7.
28. Stammberger H. Personal endoscopic operative technic for the lateral nasal wall–an endoscopic surgery concept in the treatment of inflammatory diseases of the paranasal sinuses. Laryngol Rhinol Otol (Stuttg). 1985;64(11):559–66.
29. Tos M, Drake-Lee AB, Lund VJ, Stammberger H. Treatment of nasal polyps–medication or surgery and which technique. Rhinol Suppl. 1989;8:45–9.
30. Seiberling KA, Church CA, Tewfik M, Foreman A, Chang D, Ghostine M, Wormald PJ. Canine fossa trephine is a beneficial procedure in patients with Samter's triad. Rhinology. 2012;50(1):104–8.
31. Poetker DM, Jakubowski LA, Lal D, Hwang PH, Wright ED, Smith TL. Oral corticosteroids in the management of adult chronic rhinosinusitis with and without nasal polyps: an evidence-based review with recommendations. Int Forum Allergy Rhinol. 2013;3(2):104–20.
32. Howard BE, Lal D. Oral steroid therapy in chronic rhinosinusitis with and without nasal polyposis. Curr Allergy Asthma Rep. 2013;13(2):236–43.

33. Poetker DM, Smith TL. What rhinologists and allergists should know about the medico-legal implications of corticosteroid use: a review of the literature. Int Forum Allergy Rhinol. 2012;2(2):95–103.
34. Richards RN. Side effects of short-term oral corticosteroids. J Cutan Med Surg. 2008;12(2): 77–81.
35. Weinstein RS. Glucocorticoid-induced osteonecrosis. Endocrine. 2012;41(2):183–90.
36. van Schaardenburg D, van den Brink HR, Wieringa HJ. Short-term steroid therapy, sometimes with long-term sequelae. Ned Tijdschr Geneeskd. 2001;145(37):1769–73.
37. Taylor LJ. Multifocal avascular necrosis after short-term high-dose steroid therapy. A report of three cases. J Bone Joint Surg Br. 1984;66(3):431–3.
38. Madanagopal SG, Kovaleski JE, Pearsall 4th AW. Survey of short-term oral corticosteroid administration by orthopaedic physicians in college and high school athletes. J Sports Sci Med. 2009;8(1):37–44.
39. Hosemann W, Draf C. Danger points, complications and medico-legal aspects in endoscopic sinus surgery. GMS Curr Top Otorhinolaryngol Head Neck Surg. 2013;12:Doc06.
40. Fokkens W, Lund V, Mullol J, European Position Paper on Rhinosinusitis and Nasal Polyps group. European position paper on rhinosinusitis and nasal polyps 2007. Rhinol Suppl. 2007;20:1–136.
41. Dalziel K, Stein K, Round A, Garside R, Royle P. Endoscopic sinus surgery for the excision of nasal polyps: a systematic review of safety and effectiveness. Am J Rhinol. 2006;20(5): 506–19.
42. Stankiewicz JA, Lal D, Connor M, Welch K. Complications in endoscopic sinus surgery for chronic rhinosinusitis: a 25-year experience. Laryngoscope. 2011;121(12):2684–701.
43. Siedek V, Pilzweger E, Betz C, Berghaus A, Leunig A. Complications in endonasal sinus surgery: a 5-year retrospective study of 2,596 patients. Eur Arch Otorhinolaryngol. 2013;270(1):141–8.
44. Rombout J, de Vries N. Complications in sinus surgery and new classification proposal. Am J Rhinol. 2001;15(6):363–70.
45. May M, Levine HL, Mester SJ, Schaitkin B. Complications of endoscopic sinus surgery: analysis of 2108 patients–incidence and prevention. Laryngoscope. 1994;104(9):1080–3.
46. Valentine R, Wormald PJ. Controlling the surgical field during a large endoscopic vascular injury. Laryngoscope. 2011;121(3):562–6.
47. Valentine R, Wormald PJ. Carotid artery injury after endonasal surgery. Otolaryngol Clin North Am. 2011;44(5):1059–79.
48. Valentine R, Wormald PJ. A vascular catastrophe during endonasal surgery: an endoscopic sheep model. Skull Base. 2011;21(2):109–14.
49. Maharshak I, Hoang JK, Bhatti MT. Complications of vision loss and ophthalmoplegia during endoscopic sinus surgery. Clin Ophthalmol. 2013;7:573–80.
50. Ilieva K, Evens PA, Tassignon MJ, Salu P. Ophthalmic complications after functional endoscopic sinus surgery (FESS). Bull Soc Belge Ophtalmol. 2008;308:9–13.
51. Bhatti MT, Stankiewicz JA. Ophthalmic complications of endoscopic sinus surgery. Surv Ophthalmol. 2003;48(4):389–402.
52. Rene C, Rose GE, Lenthall R, Moseley I. Major orbital complications of endoscopic sinus surgery. Br J Ophthalmol. 2001;85(5):598–603.
53. Davis DH, Laws Jr ER, McDonald TJ, Salassa JR, Phillips 2nd LH. Intraventricular tension pneumocephalus as a complication of paranasal sinus surgery: case report. Neurosurgery. 1981;8(5):574–6.
54. Clevens RA, Bradford CR, Wolf GT. Tension pneumocephalus after endoscopic sinus surgery. Ann Otol Rhinol Laryngol. 1994;103(3):235–7.
55. Wright ED, Agrawal S. Impact of perioperative systemic steroids on surgical outcomes in patients with chronic rhinosinusitis with polyposis: evaluation with the novel Perioperative Sinus Endoscopy (POSE) scoring system. Laryngoscope. 2007;117(11 Pt 2 Suppl 115):1–28.

56. Poetker DM, Smith TL. Adult chronic rhinosinusitis: surgical outcomes and the role of endoscopic sinus surgery. Curr Opin Otolaryngol Head Neck Surg. 2007;15(1):6–9.
57. Klossek JM, Peloquin L, Friedman WH, Ferrier JC, Fontanel JP. Diffuse nasal polyposis: postoperative long-term results after endoscopic sinus surgery and frontal irrigation. Otolaryngol Head Neck Surg. 1997;117(4):355–61.
58. Jankowski R, Pigret D, Decroocq F, Blum A, Gillet P. Comparison of radi- cal (nasalisation) and functional ethmoidectomy in patients with severe sinonasal polyposis. A retrospective study. Rev Laryngol Otol Rhinol (Bord). 2006;127:131–40.
59. Wynn R, Har-El G. Recurrence rates after endoscopic sinus surgery for massive sinus polyposis. Laryngoscope. 2004;114:811–3.
60. Hopkins C, Browne JP, Slack R, Lund V, Topham J, Reeves B, Copley L, Brown P, van der Meulen J. The national comparative audit of surgery for nasal polyposis and chronic rhinosinusitis. Clin Otolaryngol. 2006;31(5):390–8.