4.4.1 Choanal polyp

Regarding the choice of the approach, the following reflections have to be made, especially with the objective to perform safe and sufficient opening of the sphenoethmoid sinus and to avoid strictly any endangering of the internal carotid artery or the optic nerve....

4.4.3 Choanal polyp

... Many authors resect few mm or the caudal third of the superior turbinate and consider this as unproblematic [275], [333], [340], [345], [346] even if a discrete interference with the sense of smell cannot be excluded theoretically [340]. There is just one scientific study addressing this problem.

- Reaction of the inferior part of the superior turbinate (inferior third or fourth) turned out not to be associated with smelling disorder even if in a sixth of the specimens olfactory tissue could be found. On the other hand, no olfactory tissue was found in the specimens of all patients with relevant postoperative smelling disorder [347].

- Resection of the inferior part of the superior turbinate (inferior third or fourth) turned out not to be associated with smelling disorder even if in a sixth of the specimens olfactory tissue could be found. On the other hand, no olfactory tissue was found in the specimens of all patients with relevant postoperative smelling disorder [347].

- Any intercurrent acute infection needs several weeks to disappear radiologically [85], [86], [87], [88], [89], [90].

- MRI in >60%.

- CT scans reveal in up to 40% and

- of the population irrelevant focal swellings of the mucosa and that

- any intercurrent acute infection needs several weeks to disappear radiologically [85], [86], [87], [88], [89], [90].

Those factors must be borne in mind, not only during evaluation but also when fixing an appointment for radiological examination....

2.1 Optical instruments

Due to important technical development, the endoscope compared to the microscope is superior as optical device. It combines a very good overview due to wide angle technology with a very good detailed view due to HD technology, even in bloody sites. It allows looking around the corner by using angular optics under ergonomically favorable conditions due to video endoscopy. Only by means of endoscopy, a four-hand technique is possible. Even for education, training, and the control of surgical steps the endoscopic technique has more advantages. Even supervision of surgery is possible by means of teleconferencing [176].

The use of modern HD video endoscopy leads to a significantly better image quality in comparison to older systems. Based on this fact, medico-legal consequences must be considered. It is a major obligation of a hospital to provide the instruments that correspond to actual international standards [10].

... Generally, the use of a microscope further leads to a more severe traumatization in the area of the nasal entry and the turbinates. Thus the application of the microscope alone can no longer be recommended.

2.5 Technique of endonasal endoscopic sinus surgery

2.5.1 Uncinectomy

... Nearly every sinus surgery starts with uncinectomy, at least in patients who had not undergone previous interventions. Only uncinectomy allows

- the precise identification of the natural maxillary ostium and

- the exposure of the infundibulum-ethmoidal as natural drainage pathway of the anterior ethmoid and the frontal sinus.

2.5.3 Sphenoid sinus surgery

Ethmoid sinus surgery starts with uncinectomy, whereby the ethmoid infundibulum is opened (= infundibulotomy). The next and final step of anterior ethmoidectomy consists of opening the wall of the ethmoid bulla most safely at the caudal medial part and removal of its wall in cranial direction (schädelwärts) and to the edges.

If no supra-bullar recesso is found, the skull base presents in cranial direction. If no retro-bullar recess is present, the basal lamella of the middle turbinate is depicted in dorsal direction.

The posterior ethmoid sinus surgery starts with perforation of the basal lamella of the middle turbinate at the nasal inferior part, directly above the horizontal part of the basal lamella (Figure 4). The roof of the maxillary sinus is another helpful landmark for a safe surgical procedure. Remarking below the level of the maxillary sinus roof, a lesion of the ethmoid ethmoid roof itself actually not possible. It is recommended to previously analyze the topographic relation of the posterior roof of the ethmoid sinus and the roof of the maxillary sinus in the coronal CT scan. Furthermore, the preparation should be performed in horizontal anterior-posterior direction, for example in combination with a 0° optic.

Attention must be paid to the presence of a sphenono-ethmoid cell with possibly prominent or exposed optic nerve. Afterwards, interventions of the sphenoethmoid sinus and the frontal sinuses may be performed.

Figure 4: Sagittal CT demonstrating the surgical strategy to open the posterior ethmoid. After opening the basal lamella of the middle turbinate, the superior maxilla (3) is reached and (4) = ethmoid bulla.

2.5.4 Sphenoid sinus surgery

If no supra-bullar recess is found, the skull base presents in cranial direction. If no retro-bullar recess is present, the basal lamella of the middle turbinate is depicted in dorsal direction.

The posterior ethmoid sinus surgery starts with perforation of the basal lamella of the middle turbinate at the nasal inferior part, directly above the horizontal part of the basal lamella (Figure 4). The roof of the maxillary sinus is another helpful landmark for a safe surgical procedure. Remarking below the level of the maxillary sinus roof, a lesion of the ethmoid ethmoid roof itself actually not possible. It is recommended to previously analyze the topographic relation of the posterior roof of the ethmoid sinus and the roof of the maxillary sinus in the coronal CT scan. Furthermore, the preparation should be performed in horizontal anterior-posterior direction, for example in combination with a 0° optic.

Attention must be paid to the presence of a sphenono-ethmoid cell with possibly prominent or exposed optic nerve. Afterwards, interventions of the sphenoethmoid sinus and the frontal sinuses may be performed.
widened maxillary sinus ostium, inferior turbinate, antrochoanal polyp filling antrum (antrum = Höhle, auch "maxillary sinus" genannt) and right nasal cavity.

Coronal CT scan image showing the antrochoanal polyp arising from the left maxillary antrum (= Höhle) and extending into the left nasal cavity through the widened natural ostium of the sinus.

Source: OTOLARYNGOLOGY HOUSTON, BECHARA Y. GHORAYEB, MD
OTOLARYNGOLOGY HEAD & NECK SURGERY
http://www.ghorayeb.com/AntrochoanalPolyp.html

See also
http://radiopaedia.org/articles/antrochoanal-polyp-1
Case courtesy of Dr Roberto Schubert.
<a href="http://radiopaedia.org/cases/15098">rID: 15098</a>
left antrochoanal polyp
Regarding the symptom of smelling, surgery and drug therapy in CRSwNP were superior to exclusive drug therapy in a prospective, non-randomized study [1243]. The removal of polyps or parts of REAH from the olfactory region did not lead to an impaired olfaction. Previous interventions and partial resection of the middle turbinates were negative risk factors [1242]. The possibility of deterioration of olfaction (hyposmia, anosmia) in up to 10% should be mentioned preoperatively [1232], [1234], [1235], [1236]. After frontal sinus drainage type III, an improvement of olfaction was observed in 57%, no change in 29%, and deterioration in 13% [1241]. Not rarely, this leads to residual ACP parts or hidden second or third cysts that may be the origin of recurrences [672].

If the secure visualization and removal of the base of the ACP is not possible via endoscopy of the middle meatus, a complementary approach via the canine fossa should have been part of the patient’s informed consent preoperatively. In rare cases, the choanal polyp originates from the sphenoid sinus which requires the performance of an uncinectomy and removal of the intranasal part. The recurrence rates amount to totally 0–20% [574], [575], [675], [676], [677], [678], [679], [680], [681], [682], [683], [684], [685]. Despite certain methodological objections regarding a comparison, the recurrence rates in cases of additional procedure via the canine fossa are constantly lower (0–6%) than in procedures exclusively via the middle meatus. In contrast, improvements were described in 79–87% of the patients [1234], [1235] and postoperative normosmia after preoperative hyposmia was observed in 70% [1235]. Generally, patients with anosmia and CRSwNP are more likely to experience a postoperative improvement of olfaction than patients with hyposmia and CRSsNP [1231], [1233], [1236], [1237], [1238], [1239], [1240].

6.2 Improvement of single symptoms

- Antrochoanal polyps: Antrochoanal polyps (ACP) are benign lesions that develop from the mucosa of the maxillary sinus, grow through the natural or secondary ostium into the nasal cavity, reach the choanae, and lead in particular to nasal obstruction. More rarely, choanal polyps may originate in the sphenoid or ethmoid sinuses.
- Therapy of choice is the surgical removal including the base of the polyps. The simple abrasion is associated with a high recurrence rate. After removal of the intranasal part, performance of an uncinectomy and enlargement of the natural maxillary sinus ostium, the base of the polyp has to be located. This requires the application of angular optics and special angled instruments with which often the anterior wall, the palate, alveolar (Ventilations)-, or prelacrimal recesses are not seen or reached [291].
- Not rarely, this leads to residual ACP parts or hidden second or third cysts that may be the origin of recurrences [672].
- Generally, patients with anosmia and CRSwNP are more likely to experience a postoperative improvement of olfaction than patients with hyposmia and CRSsNP [1231], [1233], [1236], [1237], [1238], [1239], [1240].
- Postoperative normosmia after preoperative hyposmia was observed in 70% [1235]. In contrast, improvements were described in 79–87% of the patients [1234], [1235] and postoperative normosmia after preoperative hyposmia was observed in 70% [1235].
- Generally, patients with anosmia and CRSwNP are more likely to experience a postoperative improvement of olfaction than patients with hyposmia and CRSsNP [1231], [1233], [1236], [1237], [1238], [1239], [1240].
- The possibility of deterioration of olfaction (hyposmia, anosmia) in up to 10% should be mentioned preoperatively [1232], [1234], [1235], [1236]. After frontal sinus drainage type III, an improvement of olfaction was observed in 57%, no change in 29%, and deterioration in 13% [1241].
- The removal of polyps or parts of REAH from the olfactory region did not lead to an impaired olfaction. Previous interventions and partial resection of the middle turbinates were negative risk factors [1242].
- Regarding the symptom of smelling, surgery and drug therapy in CRSwNP were superior to exclusive drug therapy in a prospective, non-randomized study [1243].
It can be assumed in each case that the values are below those of traditional craniofacial surgery [101], [102]. The risk potential is higher in transnasal endoscopic rhinoneurosurgery; altogether this accounts for approximately 10% (–25%) of complications. The reported numbers have to be discussed; these apply to many patients with chronic rhinosinusitis are already burdened heavily simply due to their illness [66]. In other cases an unfavorable ratio results, with respect to the listed mistakes:

In general, sinus surgery has a relevant risk potential [61], [64]. When surgical errors occur in a rare case, the risk resulting in relevant physical damage is above average [65].

### 6.5 Recurrence

The reason for revision surgery is often a disturbed drainage of the frontal recess or the frontal sinus neoseptomaid caused by [15], [16], [17], [18], [362], [363], [391], [409], [1270], [1271]

- residual parts of the uncinate process and anterior ethmoid cells,
- a missed ostium of the maxillary sinus,
- a lateralized middle turbinate,
- scarring,
- osteoneogenesis, or
- recurrent polyps.

A major part of those intraoperative findings in revision surgery is based on an insufficient surgical technique applied for initial surgery [363]. A missed ostium sequence can lead to recirculation through both ostia [409], [1271] with a predisposition to develop symptoms and infections [469]. Postoperatively it is not always clear if the missed ostium sequence occurred primarily at the time of previous surgery or secondarily by scarring. Patients with missed ostium sequence have more complaints than others [469].

### Negative factors influencing the surgical outcome

- Primary nature and extent of the disease [8], [249], [1218].
- Frontal sinus involvement, which increases the risk of recurrent polyposis or revision surgery to 1.4 to 1.6 [1265]. More extensive surgery with additional interventions on the frontal sinus could significantly reduce the rate of necessary revision surgeries [19.0 % vs. 14.1%] [235].
- Previous surgery: the success rates after revision surgery are lower than after initial surgery:
  - The success rates of general symptom assessment are reduced to about 70% [1272].
  - The probability of improved symptoms is twice as high after initial intervention than after revision [20].
  - The improvement of the quality of life after revision is lower, however, similar after each additional revision surgery [1273].
- The relative risk of revision surgery after previous surgery amounted to 3.07 according to an extensive US database analysis [1274].
- Bronchial asthma [24], [333], [1272], [1265], [1275], even if the study results are partly inconsistent [1218].
- Intolerance of anesthetics [24], [1219], [1249], [1276], [1277], [1278], [1298], [1280] and Samter's triad (significantly more frequent revision surgery: 37% within 5 years and 85% within 10 years [1263]).
- Allergic fungal sinusitis [241], [1282].
- Evidence of staphylococcal infection with superantigens [1280], [1284], [1268], [1286], [1287], [1288], [1289] (see also complementary review by C. Bachert [201]).
- Evidence of bone loss [1290].
- Sin-scaled osteitis: A bone remodelling with thickening of ethmoid trabeculae and walls of the paranasal sinus correlates with the severity and extent of CRS or a condition after previous surgery [1291], [1292] and is associated with a poorer outcome [17], [1293], [1294], [1295], [1296], [1297]. Topical corticosteroids by means of nasal rinsing can possibly compensate the negative influence [1296]. Suggested classification systems are not sufficiently validated [1291]. Currently it is unclear if it is a pathognomonic factor of the disease or merely a consequence [19], [1294], [1299] and which exact pathophysiological correlations exist [1299]. Recent histological results indicate that it is not an original inflammation of the bone but rather a process of tissue remodeling as reaction on mucosal inflammation or tissue trauma, so that the term of osteoneogenesis is more appropriate [1292]. It is recommended to remove areas of thickened bone whereby this is relatively easy or possible only in the ethmoid sinuses and at the middle turbinate. On the other hand, the extent of necessary resection regarding optimal results is unclear [1291].
- Cystic fibrosis [869].
- Smoking: whereas smoking clearly contributes to CRS [1290], it is not sufficiently clarified if smoking or intensive smoking leads to postoperatively impaired quality of life and to more frequent and earlier revision surgery [22], [1301], [1302] or if it has no influence on postoperative complaints or long-term results [1284]. Smoking is not contraindicated for endoscopic sinus surgery [1300].
- The influence of allergic rhinitis on the surgical outcome is currently not clearly defined. It is recommended to preoperatively optimise therapy of the allergy in order to improve the postoperative result [1218], [1303].
- Tissue eosinophilia and histological parameters: An increased tissue eosinophilia (eosinophilia = ease with more than normal eosinophils, eosinophil = white blood cells of the granulocyte type that have rough, nuclear granules of cytoplasm that stain with eosin) correlates with a poorer surgical result and increases the risk of recurrence of CRS or MPH [20], [299], [285], [1298], [1304], [1305], [1306]. This aspect, however, was not confirmed by all studies [1308]. In patients with lower-grade tissue eosinophilia and reduced subepithelial edema, the postoperative improvement is two to four times more likely [20]. Therapy with topical steroids improves the according postoperative results [209], [1309], [1310]. Even the number of goblet cells and thickening of the basal membrane are said to correlate with the severity of the disease and a poorer surgical outcome [1311], [1312].
- Immunodeficiency is not a negative predictor, the results are comparable to those of patients with a normal immune system [19], [1313]. There is no convincing evidence that the gastro-esophageal reflux plays a causal role in the pathogenesis of CRS [1314], [1315] and influences recurrence and revision rates of endoscopic sinus surgery [1314], [1316]. Nonetheless, a gastro-esophageal reflux disease can contribute to the symptoms, especially postnasal reflux, which has to be considered in the context of drug therapy [469], [1314], [1315], [1316], [1317], [1318].

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**Danger points, complications and medico-legal aspects in endoscopic sinus surgery**

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**1 Preface**

Endoscopic sinus surgery has undergone an enormous expansion of its reach and its indications [40], [41] in specialized centers with continued development of ‘multimodality neuro-rhinolaryngology’ [21] and endoscopic rhino-neurosurgery.

**2 Special aspects in endoscopic surgery of the paranasal sinuses**

From the patients perspective endonasal surgery for chronic rhinosinusitis can be considered effective [44]. As compared to its “effectiveness” its application regarding formal evidence of standards is far from being beyond critical discussion:

- Meticulous removal of hidden polyps in the maxillary sinus in the course of pansinus surgeries often does not achieve better results than mere conventional antrostomy [53].
- The particular advantage of an extensive removal in terms of effectiveness and safety is frequently called into question as compared to conservative methods such as a polypectomy or conservative medical therapy [46] - [50].
- Melioctic removal of hidden polyps in the maxillary sinus in the course of pansinus surgeries often does not achieve better results than mere conventional antrostomy [53].

**3 Classification of complications in endonasal sinus surgery**

In general, sinus surgery has a relevant risk potential [81], [84]. When surgical errors occur in a rare case, the risk resulting in relevant physical damage is above average (05).

Doubtlessly, many patients with chronic rhinosinusitis are already burdened heavily simply due to their illness [86]. In other cases an unfavorable ratio results, with respect to the listed mistakes:

- on the one hand there is a possibly moderate additive disease on the patient through his disease, lest risk regarding the natural course of the disease and conservative treatment alternatives.
- On the other hand the extent of potential damage and personal consequence from a complication prone surgery should be considered.

The risk potential is higher in transnasal endoscopic rhino-neurosurgery; altogether this accounts for approximately 10% – 25% of complications. The reported numbers have to be discussed; these apply to heterogeneous interventions and patients.

It can be assumed in each case that the values are below those of traditional craniofacial surgery [101], [102].

The otorhinolaryngologist as a partner in a rhino-neurosurgical team is confronted with a significantly wider spectrum of possible errors and risks during surgery. Examples are:

- Intracranial hemorrhages, e.g.:
  - damage to the chiasm or the chiasmatic cistern, the optic nerves, the optic chiasm or the optic nerves,
  - postoperative endocrine disorders,
  - secondary bleeding of branches of the sphenopalatine artery, postoperative sphenoethmoidal sinus [101], [103].
Table 1: Complications of endonasal sinus surgery (based on [82]).

<table>
<thead>
<tr>
<th>Localization/overall type of injury</th>
<th>‘minor complication’</th>
<th>‘major complication’</th>
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<tr>
<td>Orbital complication</td>
<td>Orbital emphysema</td>
<td>Orbital hematoma</td>
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<td>Ecchymosis of the eyelid</td>
<td>Reduced visual acuity / blindness</td>
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<td>Encephalitis</td>
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<td>Injury of the nasolacrimal duct</td>
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<td>Intracranial complication</td>
<td>Uncomplicated CSF fistula</td>
<td>CSF leak</td>
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<td>(Eisenmenger-pneumcephalus)</td>
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<td>Encephalocoele</td>
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<td>Brain abscess</td>
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<td>Meningitis</td>
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<td>Intracranial (subarachnoid) haemorrhage</td>
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<td>Direct injury of brain tissue</td>
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<td>Bleeding</td>
<td>minor bleeding (stopped with nasal packing, no need for blood transfusion)</td>
<td>Injury of the ant. ethmoidal artery</td>
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<td>Injury of the sphenoparietal artery</td>
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<td>Injury of internal carotid artery</td>
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<td>Bleeding in need of transfusion</td>
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<td>other</td>
<td>Synchiae</td>
<td>Anceps</td>
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<td>Slight exacerbation of pre-existing bronchial asthma</td>
<td>Severe exacerbation of a pre-existing bronchial asthma or bronchospasm</td>
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<td>Hyposmia</td>
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<td>Local infection (naevoid)</td>
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<td>Postoperative MRSA-infection</td>
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<td>Aspergillus</td>
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<td>Paraffinoma</td>
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<td>Myosphenoblastes</td>
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<td></td>
<td>Temporal inflation of the intracranial nerve</td>
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<td></td>
<td>Hypoesthesia of the lip or teeth</td>
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Begriffserklärung:
- emphysema: Eintritt von Luft
- ecchymosis: Hämatom
- Synchiae: Augeninnendruck
- Hypnosia: Diplopie
- Local infection: lokale Infektion
- Postoperative MRSA-infection: postoperativer MRSA-Infekt
- Aspergillus: Schimmelpilze
- Paraffinoma: Paraffinomase
- Myosphenoblastes: Myosphenoblasten
- Temporal inflation: Temporalen Druck
- Hypoesthesia: Schwellungen

If data from the “beginning international phase” (“surgical innovation adoption curve”) of endoscopic surgery (such as 1988 to 1998) is excluded, endoscopic surgery displays a comparable safe procedure according to the subsequent comparison of literature [86]. The complication rate has globally decreased slightly during the past few years [14].

4 “Minor” complications

4.1 Damage of the lamina papyracea – orbital emphysema, prepaetal bleeding

4.2 Uncomplicated bleeding of the mucosa

Epidemiology

Small and isolated CSF fistulas, which are treated at once successfully, count statistically as “minor complication” [86].

- Those particular incidents are not rare – in a survey 25% of American otolaryngologists had experienced at least one unexpected CSF fistula intraoperatively during the last 5 years [198].
- The rate of unexpected dura exposure is reported with a percentage of 0.2% [225].
- The number of minimal, temporary and occult leakage of cerebrospinal fluid is around 0.2% [195].

Diagnosis

- In most cases cerebrospinal fluid fistulas are clinically apparent – clear liquid flows into the operating field. Microanatomical structures are “cleared” unnaturally [76], [197].
- In other cases the fistula remained unnoticed at first [68], [193], [199]. In some studies a state of 50% [193].
- In a few percent of cases the diagnosis was made only after surgery [68], [198], [199].

In isolated cases cerebrospinal fluid fistulas were detected with fluorescein, neither with beta trace nor with beta 2 transferase [217]. Nevertheless even fluorescein has a limited sensitivity (74%–90%). False-negative samples may occur, among others, due to a temporary blockage of the fistula through e.g. bleeding or possibly air bubbles trapped intraoperatively or even accumulated fluid [113], [211], [202].

Regarding CT scans the quality of the image is crucial; reconstructed coronal planes frequently lead to misinterpretations [193], [205].

Under ideal conditions

- Over 90% of fistulas are detected via high resolution (0.625 mm – 1.25 mm) CT scans in axial plane and multiplanar reconstruction;

In individual cases subclinical fistulas were detected with fluorescein, neither with beta trace nor with beta 2 transferase [217]. Nevertheless even fluorescein has a limited sensitivity (74%–90%). False-negative samples may occur, among others, due to a temporary blockage of the fistula through e.g. bleeding or possibly air bubbles trapped intraoperatively or even accumulated fluid [113], [211], [202].

In case of a persisting leak encountered during routine sinus surgeries or e.g. after rhino-neurosurgical procedures, surgical treatment should be pursued even with small defects.

Surgical management

Lamellagene cerebrospinal fluid fistulas are usually below 3mm in size, in some cases 3–20 mm [192], [226], [227].

If data from the “beginning international phase” (“surgical innovation adoption curve”) of endoscopic surgery (such as 1988 to 1998) is excluded, endoscopic surgery displays a comparable safe procedure according to the subsequent comparison of literature [86]. The complication rate has globally decreased slightly during the past few years [14].
The Injury of the anterior ethmoidal a.

5.2 Relevant bleeding (anterior ethmoidal a., posterior ethmoidal a., sphenopalatine a. and internal carotid a.)

5.1 Orbital haematoma

temporary reduction of the lacrimal secretion (xerophthalmia, postoperative incidence 12–30%) and reduction of the moistening of nasal mucous membranes [331], [332]. Past references depict single cases of transpterygoid (Pterygoid ist ein Knochen der hinteren Gaumenregion)...

In about 3% for all cases combined [72].

As a consequence, facial sensibility is affected postoperatively [76], [288] (Figure 5). The same applies to the alveolar nerves. The rate of postoperative sensibility disorders of teeth or lips and cheeks respectively is

In a rather aggressive mode of preparation or when electrosurgical measures are applied in the maxillary sinus, an injury of the infraorbital n. at the roof of the maxillary sinus may result.

A number of factors determine the particular risk associated with a large dura defect:

- the kind and stability of the defect closure as well as
- local dead space,
- tissue texture,
- infection and/or cerebral abscesses

In the majority of cases, especially for postoperative persisting heavy fluid flow from the maxillary sinus, revision surgery is advisable [102].

An early drainage can help to relieve pressure variations within the area of transplantation during extubation [233]. In about 13% of the cases however, the drainage causes more or less relevant side effects or

4.5 Hyposmia

A meta-analysis showed no significant difference regarding success rate, stating that revision surgery is generally performed in about 90% of all cases for small defects to up to 97% [75], [191], [203], [213], [216], [206], [217], [394]. Recurrence of fistula is frequently observed in patients with an increased CSF pressure [201].

Active CSF fistulas may result in meningitis:

- The cumulative risk for 10 years in indexed with 8%;
- in different case series it is rated at approx. 20%, with an accumulation in the first couple of months [245], [244].

This risk is relatively reduced to 0–1% long-term [201], [247].

In a few cases (0.3 to 0.9%) postoperative complications are reported, such as

- headaches,
- secondary sinusitis,
- intranasal/mucosal haemorrhages or abscesses,

vision problems or
cases may occur after direct mechanical trauma, after removal of olfactory mucosa accompanied by scarification

The number of lateral synechiae also decreased, although the synechiae developing during therapy in spite of partial resection were more challenging [299], [300], [301].

In individual cases, an “empty nose” syndrome has developed after resecting the middle nasal turbinate [293].

The initial exposition of the defect is important. The area of the skull base defect needs to be "cleaned" from mucosa remnants and is prepared for the closure. If the leak is not easily identified, it may help to tilt the patient’s head low and to ask the anesthesiologist to perform an epistaxis drainage

... In... in the turbinate bone can also be damaged without any resection, e.g. by mere fractures occurring in the context of a “mobilization” of the turbinates – however, because of the remaining septal fibrils, a hypertrophy of the turbinates may result in meningitis.

... As a consequence, facial sensibility is affected postoperatively [76], [180]...

... Of the anterior 3/4 bony part of the common vertical lamella of the middle and superior nasal turbinate (“conchal plate”),

• in the majority of cases it is rated at approx. 20%, with an accumulation in the first couple of months [245], [244].

The so-called “missed ostium sequence” develops in case of suboptimal fenestration of the maxillary sinus via middle meatus with a untouched, separate and insufficient natural maxillary ostium (covered by

... In general, postoperative small defects may occur after direct mechanical trauma, after removal of olfactory mucosa accompanied by decortications of the nasal air passage. A partial resection of the lower third of the anterior middle nasal turbinate does not affect the ability to smell. In revision procedures, there was no evidence of olfactory mucosa in the surgical specimens [214]. On the other hand, a complete postoperative anosmia was reported, following a resection of the superior nasal turbinate that was done mistake [313].

In general, the anterior ethmoidal a. can be easily injured during surgery of the anterior ethmoid.

5.4 Hypoxia

In human anatomy the exact dimension of the olfactory region is unknown. It is formed [311], [312], [313] by an area consisting

- of the anterior 3/4 bony part of the common vertical lamella of the middle and superior nasal turbinate (“conchal plate”),

• together with the dural part of the roof of the nasal cavity

- and the adjoining parts of the nasal septum.

In general, postoperative small defects may occur after direct mechanical trauma, after removal of olfactory mucosa accompanied by decortications of the nasal air passage. A partial resection of the lower third of the anterior middle nasal turbinate does not affect the ability to smell. In revision procedures, there was no evidence of olfactory mucosa in the surgical specimens [214]. On the other hand, a complete postoperative anosmia was reported, following a resection of the superior nasal turbinate that was done mistake [313].

In a rather aggressive mode of preparation or when electrosurgical measures are applied in the maxillary sinus, an injury of the infraorbital n. at the roof of the maxillary sinus may result.

A number of special factors determine the particular risk associated with a large dura defect:

- cerebrospinal fluid fistulas can be operated with a delay after extended surgical procedures, i.e. within 7 days,

- high-flow bypass fistulae need to be operated immediately [201].

An early drainage can help to relieve pressure variations within the area of transplantation during extubation [233]. In about 13% of the cases however, the drainage causes more or less relevant side effects or

In a rather aggressive mode of preparation or when electrosurgical measures are applied in the maxillary sinus, an injury of the infraorbital n. at the roof of the maxillary sinus may result.

A number of special factors determine the particular risk associated with a large dura defect:

- cerebrospinal fluid fistulas can be operated with a delay after extended surgical procedures, i.e. within 7 days,

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A number of special factors determine the particular risk associated with a large dura defect:
Postoperative Meningitis is rare, although it represents the most frequent intracranial complication in paranasal sinus surgery. It spreads through Meningitis, brain abscess, intracranial haemorrhage, base defect [491], [496].

After the diagnosis has been confirmed in the emergency CT scan, immediate neurosurgical decompression has to take place, e.g. by trepanation or performing a puncture, with simultaneous closure of the skull base defect [491], [498].

5.3 Reduced vision, visual field defects
The optic n. often bulges into the superior lateral wall of the sphenoid sinus. In this regard, very different frequencies are found in literature: 8–100% [12].

5.4 Diplopia

Generally 5 typical causes for a postoperative motility disorder of the eye may be distinguished:

1. Partial or complete transaction of the muscle.
2. Contusion with hematoma of the muscle tissue.
3. Partial or complete transaction of the line of transition between the middle and the dorsal third of the medial rectus muscle.
4. Proptosis and incarceration of muscle parts and/or fat into a defect of the orbital wall.
5. Destruction of intraorbital fascia with irregular scarring (“fat adherence syndrome”) [363], [453], [455], [456].

Very often (50%), eye muscle damage is not revealed intra-operatively by the surgeon [403]. Muscle tissue that is quickly destroyed through the ‘shaving action’. This may also occur without any prominent orbital injury. Often the surgeon is not even aware of the damage.

Two to three months after a damage caused to the medial rectus m., strabismus surgery is indicated [116]. In two thirds of cases, several operations will be necessary [358], [458]. In the majority of cases after an injury, the surgeon is not even aware of the damage.

Injuries of the inferior oblique m. have also been described [71], [76], [104], [363], [451], [452], [453].

5.5 Enophthalmos

In endonasal surgery of the paranasal sinuses, an impairment of the medial rectus muscle (m) is likely to occur with an incidence of approximately 1/1000. In general, these injuries result of a fracture of the inferior lamina papracea with perforation, destruction, or incarceration of the muscle. The middle or posterior ethmoid is most at risk – as hardly any fat is situated between the muscle and the bony orbital wall [76], [104], [363], [449]. In rare cases, there is a particular risk due to a congenital or posttraumatic bulge of the lamina papracea with or without direct embedding of parts of the muscle [107], [460].

Other eye muscles are distinctly less often injured intra-operatively:

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 with a drill for instance. Injuries of the inferior oblique m. have also been described [71], [104], [363], [455], [456].

In the majority of cases, only one eye muscle is damaged, with a relevant orbital hematoma developing additionally in one quarter of patients. Occasionally, however, severe combined damage affecting three muscles, for example, has been observed with additional bleeding, retinal damage or lesions of the optic nerve [n], or of the oculomotor n. [104], [453], [454].

Injuries of the inferior oblique m. have also been described [71], [104], [363], [455], [456].

An injury mostly occurs during infundibulotomy (uncinectomy), during surgery on the anterior frontal recess or during maxillary sinus fenestration in the anterior middle nasal passage – in the latter, particularly during the use of the backward cutting punch [71], [288].

Injuries of the inferior oblique m. have also been described [71], [104], [363], [455], [456].

Destruction of intraorbital fascia with irregular scarring (“fat adherence syndrome”) [363], [453], [455], [456].

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5.2.1.1 Lipoma (Fettgewebszyste)
Lipomas that occur within the orbit grow slowly over many years and do not affect vision. They are discovered incidentally during imaging studies or because of cosmetic reasons. They can be removed surgically to improve cosmetic appearance.

5.2.2.2 Ossification of the maxillary sinus mucosa
Ossification of the maxillary sinus mucosa is a rare condition that may occur as a result of chronic sinusitis or trauma. It can lead to cosmetic deformity and increased pain. Surgical intervention may be necessary.

5.2.3.1 Enlargement of the palpebral fissure
Enlargement of the palpebral fissure may occur as a result of muscle injury or trauma. It can also be a cosmetic concern. Treatment options include muscle repositioning or fascia lata grafting.

5.2.4.1 Ptosis (drooping of the upper lid)
Ptosis is a condition in which the upper eyelid droops over the eye. It can be caused by muscle injury, trauma, or aging. Treatment options include surgery to reposition the muscle.

5.2.5.1 Diplopia (double vision)
Diplopia can be caused by muscle injury, trauma, or aging. It can also be caused by other eye conditions such as strabismus or keratoconus. Treatment options include muscle repositioning, strabismus surgery, or contact lenses.

5.2.6.1 Enophthalmos
Enophthalmos is a condition in which the eye appears sunken into the socket. It can be caused by muscle injury, trauma, or aging. Treatment options include muscle repositioning, fat grafting, or orbital rim reconstruction.

5.2.7.1 Exophthalmos
Exophthalmos is a condition in which the eye protrudes from the socket. It can be caused by muscle injury, trauma, or aging. Treatment options include muscle repositioning, fat grafting, or orbital rim reconstruction.

5.2.8.1 Retrolabial fat pad
The retrolabial fat pad is a collection of fat located behind the lower eyelid. It can be a cosmetic concern in some individuals. Treatment options include fat grafting or surgical repositioning.

5.2.9.1 Skull base injury
Skull base injuries can be caused by trauma or surgical procedures. Treatment options include surgical repair, bone grafting, or nerve grafting.

5.3.1.1 Retinal detachment
Retinal detachment is a condition in which the retina separates from the underlying choroid. It can lead to blindness if not treated. Treatment options include laser photocoagulation, cryotherapy, or surgical repair.

5.3.2.1 Uveitis
Uveitis is an inflammation of the uveal tract (iris, ciliary body, and choroid). It can be caused by infection, autoimmune disease, or trauma. Treatment options include anti-inflammatory medications, topical steroids, or immunosuppressive therapy.

5.3.3.1 Choroidal neovascularization
Choroidal neovascularization is an abnormal growth of blood vessels in the choroid layer of the retina. It can cause vision loss. Treatment options include laser photocoagulation, photodynamic therapy, or surgical vitreous detachment.

5.3.4.1 Vitreous detachment
Vitreous detachment is a condition in which the vitreous gel separates from the retina. It can lead to vision loss if not treated. Treatment options include laser photocoagulation, cryotherapy, or surgical vitreous detachment.

5.4.1.1 Diplopia
Diplopia is a condition in which a person sees double. It can be caused by muscle injury, trauma, or aging. Treatment options include muscle repositioning or strabismus surgery.

5.4.2.1 Enophthalmos
Enophthalmos is a condition in which the eye appears sunken into the socket. It can be caused by muscle injury, trauma, or aging. Treatment options include muscle repositioning, fat grafting, or orbital rim reconstruction.

5.4.3.1 Exophthalmos
Exophthalmos is a condition in which the eye protrudes from the socket. It can be caused by muscle injury, trauma, or aging. Treatment options include muscle repositioning, fat grafting, or orbital rim reconstruction.

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5.6.2.1 Enophthalmos
Enophthalmos is a condition in which the eye appears sunken into the socket. It can be caused by muscle injury, trauma, or aging. Treatment options include muscle repositioning, fat grafting, or orbital rim reconstruction.

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5.6.5.1 Skull base injury
Skull base injuries can be caused by trauma or surgical procedures. Treatment options include surgical repair, bone grafting, or nerve grafting.
Olfactory function was assessed by the traditional Chinese version of the University of Pennsylvania Smell Identification Test (UPSIT-TC) preoperatively and postoperatively, recorded as smell

**METHODS:**

especially by objective measurements, is still lacking. Surgery (ESS). Although several studies have shown that 50-83% of patients may notice an improvement in olfactory function after ESS, the olfactory improvement after revision ESS (RESS),

**BACKGROUND:**

Hsu CY

Objective olfactory outcomes after revision endoscopic sinus surgery.

Am J Rhinol Allergy.

==========================================

PMID: 22311839 [PubMed - indexed for MEDLINE]

ESS in a modern context.

The incidence of major complications associated with ESS appears to have decreased since early reports over 10 years ago. There may be different complication rates in the pediatric population. Study

Examination of the impact of image guidance (IGS) was limited by study design.

RESULTS:

Retrospective review of a nationwide database of patients who underwent ESS between 2003 and 2007. Major postoperative complications—cerebrospinal fluid (CSF) leak, orbital injury, and hemorrhage

METHODS:

relatively small patient cohorts in academic institutions. The aim of this study was to update data regarding major complication rates associated with ESS by analyzing a large patient database.

BACKGROUND:

Ramakrishnan VR

The rate of postoperative anosmia as a complication of sinus surgery is about 0.07% to 1% [72], [534]. Altogether, the rate of postoperative anosmia is approximately 2% [326], [393]

**5.10 Toxic shock syndrome**

s age, pathology, or the duration of a lumbar drainage do not affect the rate of meningitis. On the contrary, earlier irradiation, the patient

CONCLUSION:

... In rhino-neurosurgical procedures, the postoperative rate of meningitis is about 1–3% [102], [237], [248], [501], [502]. Risk factors are

**5.9 Direct mechanical cerebral trauma, severe combined injuries**

Additionally this may result in

... In rhino-neurosurgical procedures, the postoperative rate of meningitis is about 1–3% [102], [237], [248], [501], [502]. Risk factors are

**5.11 Anosmia**

In rhino-neurosurgical surgery, anosmia may be an inevitable consequence due to tumour resection e.g. in the olfactory fossa –

**5.8 Postoperative anosmia**

post-operative formation of crusts or following chronic or acute rhinosinusitis without any abnormalities [528], [529], [530], [531].

Figure 14: Postoperative axial CT scan following seemingly uneventful routine paranasal sinus surgery. Obviously a major skull base perforation has happened and a piece of bone (red arrow) was transferred into the remote brain tissue. The surgeon noticed an increased intraoperative blood loss only. Fatal, partially lethal complications with mechanical destruction of cerebral tissue are limited to extremely rare cases in routine paranasal sinus surgery. Corresponding reports are mostly from earlier decades [349], [519]. In individual cases, severe combined injuries of brain and vessels can occur, e.g. with a traumatic anosmia of the anterior cerebral a. [198]. Smaller case series report a clustering of corresponding incidents, partly on the right hand side and partly on the left hand side [326], [327]. Intraoperatively, the surgeon is mostly not aware of life-threatening brain damage, often only a “striking bleeding tendency” is registered (Figure 14). The removal of “indistinct tissue” for histological analysis, which then turns out to be orthotopic cerebral tissue, is tragic. In individual cases, severe combined injuries of brain and vessels can occur, e.g. with a traumatic anosmia of the anterior cerebral a. [198]. Smaller case series report a clustering of corresponding incidents, partly on the right hand side and partly on the left hand side [326], [327]. Intraoperatively, the surgeon is mostly not aware of life-threatening brain damage, often only a “striking bleeding tendency” is registered (Figure 14). The removal of “indistinct tissue” for histological analysis, which then turns out to be orthotopic cerebral tissue, is tragic. ... Serious injury patterns have also been induced accidentally with the shaver (= rotation suction knife was developed in beginning 1985 in orthopedic surgery. In the field of otolaryngology it was used in 1992-1994).

**5.11 Anosmia**

The rate of postoperative anosmia as a complication of sinus surgery is about 0.07% to 1% [72], [534]. Altogether, the rate of postoperative anosmia is approximately 2% [326], [393]

**5.10 Toxic shock syndrome**

In a large number of cases the initial source is nasal packing. The incidence of TSS in nasal surgery is indicated with 16/100.000. Rare cases have occurred in connection with the use of septum foils, due to a special post-operative formation of crusts or following chronic or acute rhinosinusitis without any abnormalities [528], [529], [530], [531].
For adult patients with uncomplicated CRS

A total of 624 clinical scenarios were ranked, 312 scenarios each for CRS with and CRS without nasal polyps.

RESULTS:

The RAND/UCLA appropriateness methodology was performed. An international, multi-disciplinary panel of 10 experts in CRS was formed and completed two rounds of a modified Delphi ranking process along with a face-to-face meeting.

METHODS:

Uncomplicated CRS.

Appropriate indications for endoscopic sinus surgery (ESS) for chronic rhinosinusitis (CRS) are currently poorly defined. The lack of clear surgical indications for ESS likely contributes to the large variability in the selection of suitable candidates for ESS. CRS-related olfactory dysfunction is a complex clinical scenario and it is challenging to predict improvement following ESS. CRS patients with anosmia and nasal polyposis preoperatively may have a higher likelihood of olfactory improvement following ESS.

INTRODUCTION:

Olfactory dysfunction is a common complaint in patients with chronic rhinosinusitis (CRS). The purpose of this article is to review the current evidence on the impact of endoscopic sinus surgery (ESS) on CRS-related olfactory dysfunction.

PURPOSE OF REVIEW:

The recent literature suggests that olfactory outcomes after ESS are challenging to predict. Some evidence supports a positive impact of ESS on improving olfactory outcomes in patients with preoperative nasal polyposis and anosmia. However, despite improvements in smell, most of these patients remain with severe hyposmia. One study suggests ESS has no impact on olfactory outcomes.

SUMMARY:

CRS-related olfactory dysfunction is a complex clinical scenario and it is challenging to predict improvement following ESS. CRS patients with anosmia and nasal polyposis preoperatively may have a higher likelihood of olfactory improvement following ESS.

Early studies supported the role of ESS to improve CRS-related olfactory dysfunction. However, several recent larger prospective studies have improved our understanding of the impact of ESS on CRS-related olfactory dysfunction and have begun to elucidate the predictive factors associated with olfactory improvement.

In a recent 2008 study by Pate et al., evaluated 206 patients with olfactory impairment who elected ESS for CRS. They demonstrated that:

22% of patients received improvement,
66% received no change, and
9% got worse after ESS.

They hypothesized that anosmic patients typically had a mechanical obstruction to the olfactory cleft which was amenable to surgical removal.

In a subsequent 2009 study by Li et al., 111 patients with olfactory impairment undergoing ESS for medically refractory CRS were identified. The results demonstrated that olfactory impairment:

improved following ESS for anosmic patients but
not for patients with hyposmia.

The improvements for anosmic patients were stable after 1 year follow-up.

A large prospective 2008 study by Pate et al. evaluated 206 patients with olfactory impairment who elected ESS for CRS. They demonstrated that:

22% of patients received improvement,
66% received no change, and
9% got worse after ESS.

In contrast to the above studies, a recent 2008 study by Jiang et al. evaluated the impact of ESS on olfactory outcomes in patients with medically refractory CRS. They demonstrated that ESS had no impact on olfactory improvement.

In a subsequent 2009 study by Jiang et al., evaluated the impact of olfactory function following ESS. The results demonstrated that olfactory function following ESS:

the degree of nasal obstruction,
severity of CRS,
presence of nasal polyposis, or
allergy status.

In 2010, Sauer et al., evaluated the impact of histologic markers on olfactory outcomes following ESS. They identified that olfactory impairment correlated with higher degrees of tissue eosinophilia and basement membranes thickening.

However, after controlling for nasal polyposis, none of the inflammatory histologic markers predicted olfactory improvement following ESS.

Furthermore, 75% of anosmic patients received olfactory improvement after ESS, however, despite improvement, most of these patients remained with residual severe hyposmia. This suggests that most patients with CRS and olfactory impairment suffer from some form of permanent neuroepithelial injury.

The evidence suggests that:

patients with anosmia and nasal polyposis may have a higher chance of olfactory improvement following ESS, whereas
hyposmic patients without nasal polyposis have a lower likelihood to improve following ESS.

Future research will need to further investigate the role of histologic markers as predictive factors in olfactory improvement following ESS.

Similar articles

- Ethmoid histopathology does not predict olfactory outcomes after endoscopic sinus surgery.
- Defining appropriateness criteria for endoscopic sinus surgery during management of uncomplicated adult chronic rhinosinusitis: a RAND/UCLA appropriateness study.
- Appropriate indications for endoscopic sinus surgery (ESS) for chronic rhinosinusitis (CRS) are currently poorly defined. The lack of clear surgical indications for ESS likely contributes to the large geographic variation in surgical rates and contributes to reduced quality of care. The objective of this study was to define appropriateness criteria for ESS during management of adult patients with uncomplicated CRS.

METHODS:

The RAND/UCLA appropriateness methodology was performed. An international, multi-disciplinary panel of 10 experts in CRS was formed and completed two rounds of a modified Delphi ranking process along with a face-to-face meeting.

RESULTS:

A total of 624 clinical scenarios were ranked, 312 scenarios each for CRS with and CRS without nasal polypos.

For adult patients with uncomplicated CRS with nasal polypos, ESS can be appropriately offered when:

- the CT Lund-Mackay score is ≥ 3 and
- the CT Lund-Mackay score is ≥ 4.
has been a minimal trial of a topical intranasal corticosteroid +

a short-course of systemic corticosteroid with a post-treatment total Sino Nasal Outcome Test (SNOT-22) score ≥ 20

For adult patients with uncomplicated CRS without nasal polyps, ESS can be appropriately offered when

the CT Lund-Mackay score is ≥ 3 and

there has been a minimal trial of a topical intranasal corticosteroid + another

a short-course of a broad spectrum/culture-directed systemic antibiotic or

the use of a prolonged course of systemic low-dose anti-inflammatory antibiotic with a post-treatment total SNOT-22 score ≥ 20.

CONCLUSIONS:
This study has developed and reported a list of appropriateness criteria to offer ESS as a treatment “option” during management of uncomplicated adult CRS. The extent or technique of ESS was not addressed in this study and will depend on surgeon and patient factors. Furthermore, these criteria are the minimal criteria to make ESS a treatment “option” and do not imply that all patients meeting these criteria require surgery. The decision to perform ESS should be made after an informed patient makes a preference-sensitive decision to proceed with surgery. Applying these appropriateness criteria to ESS may optimize patient selection, reduce the incidence of unwarranted surgery, and assist clinicians in providing high-quality, patient-centered care to patients with CRS.

... Based on the literature review, the important clinical variables for scenario development included (Table 4):
(1) appropriate medical therapy used prior to offering ESS as a treatment option;
(2) degree of symptom or disease-specific quality of life (QoL) impairment after use of appropriate medical therapy; and
(3) results of a computed tomography (CT) of the paranasal sinuses.

MCID = Minimal Clinical Important Difference
despite the SNOT-22 being the most commonly used and highest-quality CRS-specific PROM. It is likely an imperfect instrument and there may be a small subgroup of patients with a total score of ≥ 20 that may receive an MCID of 9 points yet fail to be considered appropriate candidates for surgery (ie, risk of “underuse” for ESS).

Additionally, the MCID is derived from the population average and
there may be patients in whom an improvement of less than the MCID is clinically meaningful and
there may be patients who improve more than the MCID yet they report failure to obtain a clinically meaningful change.

Causative factors for recovery
... Without proper surgical execution, it is rare for patients to achieve success with ESS.

Most common findings were the following:

• edematous or hypertrophic mucosa (92.7%);
• retained agger nasi cell (73.4%);
• neo-osteogenesis within the frontal recess (45.9%);
• lateral scanning of the middle turbinate (47.3%);
• residual anterior ethmoid air cell (32.1%); and
• residual frontal cells (24.8%).

CONCLUSIONS:
With the exception of mucosal disease and neo-osteogenesis, all identified causes of failure of frontal sinus surgery are a result of surgical technique. Careful preoperative planning and meticulous and complete surgical execution are therefore critical for a successful surgical outcome in primary frontal sinus surgery.

Surgical versus medical interventions for chronic rhinosinusitis with nasal polyps.


Surgical versus medical interventions for chronic rhinosinusitis with nasal polyps.

Study 3: no difference was found between the groups (MD 2.3%, 95% CI -17.4% to 12.8%, n = 34).

None of the included studies reported recurrence rates.

No differences were found for any objective measurements or olfactory tests in those studies in which they were measured.

Complications

Complication rates were not reported in all studies, but rates of up to 21% for medical treatment and 14.3% for surgical treatment are described. Epistaxis was the most commonly reported complication with both medical and surgical treatments, with severe complications reported rarely.

AUTHORS’ CONCLUSIONS:
The evidence relating to the effectiveness of different types of surgery versus medical treatment for adults with chronic rhinosinusitis with nasal polyps is of very low quality. The evidence does not show that one treatment is better than another in terms of patient-reported symptom scores and quality of life measurements. The one positive finding from amongst the several studies examining a number of different comparisons must be treated with appropriate caution, in particular when the clinical significance of the measure is uncertain.

As the overall evidence is of very low quality (serious methodological limitations, reporting bias, indirectness and imprecision) and insufficient to draw firm conclusions, further research to investigate this problem, which has significant implications for quality of life and healthcare service usage, is justified.

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The Lund-Mackay staging system for chronic rhinosinusitis: how is it used and what does it predict?

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OBJECTIVES:
The Lund-Mackay score (LMS) is widely used in assessment of chronic rhinosinusitis. We aimed to describe its relationship to other measures of pre- and post-treatment health status.

STUDY DESIGN:
Multicenter prospective study of 1840 patients undergoing surgery for chronic rhinosinusitis in the UK.

RESULTS:
There was no absolute threshold for surgery, but patients with higher LMS underwent more extensive surgery.
There was no correlation between LMS and SNOT-22 scores.
The LMS increased with increasing grade of polyposis.
The LMS was associated with
- symptom reduction (coefficient = 0.24, P = 0.02)
- complication rates (odds ratio, 1.08, 95%CI 1.06 to 1.1), and
- revision rates (odds ratio, 1.03, 95% CI 1.001 to 1.06).

CONCLUSIONS:
The LMS measures a different aspect of disease to "subjective" symptom scores. However, it correlates well with other markers of disease severity, the nature of surgery offered, and its outcome.

SIGNIFICANCE:
This demonstrates the strengths and limitations of a commonly used staging system.

Sino-nasal Outcome Test (SNOT-22): A predictor of post-surgical improvement in patients with chronic sinusitis

Joshua L Kennedy1,*, Matthew A Hubbard2,*, Phillip Hoytih, MO,3 James T Petrign, MO,1 Larry Borish, MO,1 and Spencer C Payne1,2

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Keywords: Chronic Rhinosinusitis (CRS), Sino-nasal Outcome Test-22 (SNOT-22), Functional Endoscopic Sinus Surgery (FESS), Predictive factors, Asthma, Allergy,

The goal of this study was to analyze outcomes of FESS using prospectively collected data in a single surgeon series obtained through a symptom-based rhinosinusitis outcome measure, the Sino-Nasal Outcome Test-22 (SNOT-22). Additionally, demographic and baseline measures including
- asthma and smoking status,
- total IgE,
- absolute eosinophil counts (AEC),
- number of prior sinus surgeries, and
- Lund-Mackay CT scoring (LMS)
were obtained for each subject and analyzed for correlation with surgical outcomes.

Lastly, we wanted to define whether the additional two questions in the SNOT-22 as compared to the SNOT-20
- "nasal obstruction" and
- "loss of smell and taste"
added any predictive value to this patient-directed outcome measure.

The predictive value of such correlations will be useful to the surgeon in patient selection and informative to the patient in consenting to operative intervention
Standard protocol for all patients presenting for evaluation also included completion of the SNOT-22 prior to and following surgical intervention.

Each subject completed the SNOT-22 during a clinic visit by answering all questions based on a 0–5 scale, where

- 0 defines no problems with the given symptom and
- 5 defines maximal problems (supplemental Figure S1).

This is a validated patient-reported measure of outcome established to delineate the presence and severity of sino-nasal disorders.15

**Figure 1:** Univariate analysis of Post-operative Improvement in SNOT-22 Scores by Question

Abbreviations: PP - pain/pressure; *P/P: Pain/Pressure; # PND - post-nasal drip (f).

---

**Table S1.** Summary for the post-operative improvement in the mean SNOT-22 questionnaire scores unaccounted for the baseline score.

<table>
<thead>
<tr>
<th>Question</th>
<th>Estimate</th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embarrassed</td>
<td>72.1</td>
<td>67.3</td>
<td>76.9</td>
</tr>
<tr>
<td>Fatigue</td>
<td>61.4</td>
<td>56.0</td>
<td>66.8</td>
</tr>
<tr>
<td>Ruffy Nose</td>
<td>60.6</td>
<td>49.2</td>
<td>71.9</td>
</tr>
<tr>
<td>Nasal Obstruction</td>
<td>64.2</td>
<td>50.7</td>
<td>77.9</td>
</tr>
<tr>
<td>Frustrated/resident/habit</td>
<td>56.8</td>
<td>45.3</td>
<td>68.4</td>
</tr>
<tr>
<td>Lack of a good nights sleep</td>
<td>56.7</td>
<td>46.6</td>
<td>66.8</td>
</tr>
<tr>
<td>Ear pain</td>
<td>55.4</td>
<td>34.9</td>
<td>76.0</td>
</tr>
<tr>
<td>Nose is blue</td>
<td>54.4</td>
<td>31.6</td>
<td>77.1</td>
</tr>
<tr>
<td>Headache</td>
<td>54.0</td>
<td>43.5</td>
<td>66.7</td>
</tr>
<tr>
<td>Tired nasal discharge</td>
<td>53.9</td>
<td>43.7</td>
<td>63.3</td>
</tr>
<tr>
<td>Reduced productivity</td>
<td>53.6</td>
<td>40.5</td>
<td>66.8</td>
</tr>
<tr>
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<td>65.7</td>
</tr>
<tr>
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<td>49.2</td>
<td>37.5</td>
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</tr>
<tr>
<td>Wake up early</td>
<td>47.5</td>
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<td>Ear fulness</td>
<td>47.1</td>
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<td>56.7</td>
</tr>
<tr>
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<td>46.8</td>
<td>34.0</td>
<td>57.1</td>
</tr>
<tr>
<td>Wake up late</td>
<td>46.4</td>
<td>34.7</td>
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<td>45.5</td>
<td>29.9</td>
<td>58.2</td>
</tr>
<tr>
<td>Congest</td>
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<td>29.0</td>
<td>56.4</td>
</tr>
<tr>
<td>Loss of smell</td>
<td>35.1</td>
<td>21.2</td>
<td>51.1</td>
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**Abstract**

**Background:**
The purpose of this study was to investigate the impact of serum eosinophilia in the prognosis of chronic rhinosinusitis (CRS). Eosinophils are now considered to play a major role in the pathogenesis of CRS. To date, no study has evaluated the clinical course of patients with CRS and serum eosinophilia.

**Methods:**
A retrospective chart review of 620 patients who underwent endoscopic sinus surgery (ESS) for CRS was performed. 31 patients (5%) had elevated serum eosinophil counts and served as the study group. Patient charts of the

- [31 (patient)] study group and
- [34 (5%) controls with normal serum eosinophil counts were reviewed for comorbid diseases including asthma, polyps, and allergic fungal sinusitis. The number of ESSs performed and the postoperative recurrence of multiple sinus infections and need for antibiotics, systemic steroids, and antifungal agents were compared.

**Results:**
A higher proportion of patients with serum eosinophilia had a history of asthma, polyp disease, and allergic fungal sinusitis. Postoperatively, the study group had a statistically significant difference (p < 0.05) as compared with controls with respect to postoperative recurrent

- sinus infections (94% versus 32%) and
- polyp disease (35% versus 3%).

Statistical difference between study and control groups was also found with respect to the

- postoperative need for antifungal agents (23% versus 3%),
- multiple courses of antibiotics (85% versus 32%), and
- revision ESS (94% versus 24%).

Although not statistically significant, a higher proportion of the study group required systemic steroids.

**Conclusions:**
CRS patients with serum eosinophilia have a worse prognosis when compared with controls. Patients with eosinophilia should be counseled appropriately, and the physician should be aware of the
Chronic rhinosinusitis: risk factors for the recurrence of chronic rhinosinusitis based on 5-year follow-up after endoscopic sinus surgery.

BACKGROUND:
Chronic rhinosinusitis (CRS) is one of the most frequent chronic diseases in the US, and little is understood about its pathogenesis. This study was conducted to characterize, retrospectively, the clinical, objective and immunological parameters that accompany recurrence of CRS during long-term follow-up after surgery.

METHODS:
56 patients with CRS who had undergone endoscopic sinus surgery were followed up for 5 years after the surgery. The CRS parameters chosen were as follows:

- history of asthma and/or allergic rhinitis,
- periostinal eosinophilia of at least 520 cells/µl,
- mucoal eosinophil count,
- total IgE,
- presence of polyps,
- CT score,
- presence of fungal (positive fungal culture or slant),
- mucus or mucedal eosinophilia,
- mucedal eosinophil count,
- presence of acute infection after surgery,
- gender and age.

Individual correlations and stepwise regression were performed.

RESULTS:
1. Patients with a total peripheral eosinophil count of 520 cells/µl or more and those with asthma were likely to experience recurrence of CRS within 5 years after surgery.
2. Furthermore, patients with mucosal or mucedal eosinophilia who were diagnosed as having eosinophilic CRS (ECRS) showed a high incidence of recurrence within 5 years. The parameter of mucus or mucedal eosinophilia (diagnosis of ECRS) had a positive predictive value of 85.7%.

CONCLUSIONS:
Surgery should always examine the inflammatory infiltrate of nasal polyps or the paranasal mucosa, and patients with ECRS require anti-inflammatory medications, such as steroids, for a long time after surgery. Long-term follow-up is also essential.

Objectives/Hypothesis:
A subset of Chronic Rhinosinusitis (CRS) patients are those with eosinophilic CRS (ECRS). These patients remain the most refractory to medical and surgical intervention, and are thought to reflect an inflammatory process arising from a variety of causes. Recently the role of fungus in ECRS, defined as the presence of fungi in the eosinophilic mucin of CRS, has been proposed as causal in many cases. Other proposed causes of ECRS include bacterial superantigen induction of inflammation and aspirin sensitivity.

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Study Design:
Retrospective review.

Methods:
Histopathology from patients with previously diagnosed ECRS was prospectively re-reviewed for bacterial and fungal presence and correlated with patients' demographic data. The study population was composed of 55 cases. Specimens were collected from 34 patients, over a 5-year period from a single investigator at the University of Pittsburgh Medical Center.

Results:
Histologic presence of bacteria was shown in 34 of 55 (62%) of all ECRS specimens. Specimens with fungal colonization were more often associated with bacterial presence than without bacteria (17 of 22 [77%] vs. 5 of 22 [23%], P < .02).

Conclusions:
Bacteria were present in almost two-thirds of all specimens, and most cases of fungal presence were accompanied by bacterial presence, potentially providing support for bacteria as a source of inflammation.

Eosinophilic bacterial chronic rhinosinusitis.

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Objectives and Hypothesis:
Objectives: To investigate the association between radiological OMC occlusion and its draining sinuses in patients with eosinophilic rhinosinusitis (ECRS) compared to non-ECRS. Hypothesis: Eosinophilic rhinosinusitis is not a disease of ostiomeatal occlusion.

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The role of sinus disease in asthma.


Comparison of different surgical approaches of functional endoscopic sinus surgery on patients with chronic rhinosinusitis.

Liu LT, Deng J, Hong HY, Shi JB, Guo QY, Xu R.

Department of Otolaryngology, Weifang People’s Hospital Weifang 261041, China.

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RECENT FINDINGS:
The current classification of chronic rhinosinusitis (CRS) includes disease without and with nasal polyps, which are considered subgroups of CRS. Different patterns • of inflammatory and regulatory cytokines (involving distinguishable T-helper lymphocyte populations) and • of remodeling markers, however, were recently described to differentiate nasal polyps from CRS, yielding two discrete entities.

These subtypes expand those of lower airway diseases, such as asthma and chronic obstructive pulmonary disease, and suggest a common aetiological/pathogenetic background.

Whereas the link between nasal polyps and asthma is well established (indeed, asthma improves after medical or surgical treatment of sinus disease), that between CRS and lower airway disease is not well understood.

Recently, Staphylococcus aureus enterotoxins, acting as superantigens, were identified as a possible link between nasal polyps and asthma, resulting in severe disease manifestations in both upper and lower airways.

SUMMARY:
The role played by sinus disease in asthma is only partially understood, largely because of difficulty in the clinical classification and in basic knowledge of pathophysiological pathways. Recent research into upper airway and sinus inflammation and remodeling may reveal new perspectives and lead to a classification of sinus disease, which will facilitate appropriate clinical and epidemiological studies.

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from the article:
The relationship between sinus disease and asthma may be demonstrated by several means.
1. they may be related on an epidemiological basis,
2. demonstration of improvement in asthma after medical or surgical treatment of rhinosinusitis supports such a relationship,
3. some hypotheses have been proposed that could explain this relationship.

In a study comparing patients with mild-to-moderate asthma with severe asthma (see Table 1 of the article), patients with severe asthma had a significantly higher

• in patients with severe asthma the nasal polyps
• than in those with mild-to-moderate asthma.

In this study

• in the mild-to-moderate allergic asthma group had sinusitis (see Table 2 of the article)
• as compared with about 30% of the mild-to-moderate allergic group.

Another study (see Table 3 of the article)

• demonstrated CT scan abnormalities in about 80% of the severely asthmatic patients, and
• extensive sinus disease was identified in 30% of these patients.

Of asthmatic children, 40–70% exhibit clinical, endoscopic, or radiological findings of sinusitis.[36–42] In a group of 20 adult patients with CRS who had lung disease and 24% had asthma and 26% had small airway disease. [33]

In asthma, 7% of patients have nasal polyps.[4] The proportion is

• higher in patients with nonatopic (nicht erblich) asthma (15%) than in those with aspirin polyposis asthma (see Table 4 of the article)

Late-onset asthma is associated with development of nasal polyposis in 10–15%.[45]

In patients with nasal polyposis

• approximately 90% have atopic asthma[46] and
• 15% have aspirin-intolerance[46]

With patients having both asthma and nasal polyposis

• it is particularly APH asthma that is the first disease to develop, and
• nasal polyposis increases in 8–10% of patients observed[47]

In only 10% of these patients both diseases develop simultaneously, and

• in the remaining patients (21%) polyposis develops 2–12 years later by asthma.[46]

Patients with nasal polyposis and aspirin sensitivity

• are usually nonatopic (nicht erblich), and the prevalence increases in those older than 40 years.[48]

• when parents have asthma, nasal polyposis and aspirin sensitivity, their children more commonly have nasal polyposis and rhinosinusitis than do control children.[49]

• when patients have nasal polyposis and aspirin sensitivity, their children more commonly have nasal polyposis and rhinosinusitis than do control children.[49]

• Abnormalities in the paranasal sinuses were detected in 75% of these patients. The combination of an air-fluid level, mucosal thickening and specification was a characteristic finding in the paranasal sinuses. Nasal polyposis was diagnosed in 60% of aspirin-sensitive patients.[48]

In nasal polyposis the male: female ratio is 1: 1.

Women with nasal polyposis, however, are

• 1.6 times more likely to be asthmatic and
• 2.7 times more likely to have allergic children

than men.[45]


Authors' information

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2Department of Otolaryngology and Upper Airways Research Laboratory, University of Ghent, Belgium.

Research in immunology has brought great advances in the pathophysiology of chronic rhinosinusitis over the last 2 decades, which also has an impact on the upper airways. Our understanding of the pathophysiology of chronic rhinosinusitis developed from a mechanistic approach of view with a focus on narrow criteria and mucociliary clearance to the appreciation of a complex network of immunological pathways forming the basis of disease. We today differentiate various forms of infections, and we are able to understand complex immune-regulatory networks and the reasons for their failure, and which we have already developed innovative approaches for therapy for the most severe of subjects. Due to this we use the term in inflammation and remodeling processes within mucosal tissue, specifically on the key driving factors, new diagnostic tools and therapeutic approaches for chronic rhinosinusitis have developed; the differentiation of endotypes based on pathophysiological principles will be crucial for the use of innovative therapies, mostly humonized monoclonal antibodies. Several hundred of these antibodies are currently developed for various indications and will impact our specialty as well as pneumology to a great extent.

KEYWORDS:
Staphylococcus aureus; biologics; chronic rhinosinusitis; cluster analysis; endotypes; pathophysiology; phenotypes

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Free PMC Article

Eur 2 Clin Microbial Infect Dis. 2016 Apr 16. [Epub ahead of print]

Microbiology of chronic rhinosinusitis.

Rachid C

1Department of Otolaryngology and Upper Airways Research Laboratory, University of Ghent, Belgium; Division of ENT Diseases, CLENTEC, Kristiania Institute, University of Stockholm, Sweden.

Abstract

Most sinus infections are viral and only a small percentage develop bacterial infection.

Rhino-, influenza, and para-influenza viruses are the most frequent viral causes of sinusitis.

The most common bacterial isolates from children and adult patients with community-acquired acute bacterial sinusitis are

• Streptococcus pneumoniae,
• Haemophilus influenzae,
• Moraxella catarrhalis, and
• Staphylococcus pyogenes.

The most common isolates in chronic rhinosinusitis (CRS) are

• Staphylococcus aureus and• anaerobic organisms (Prevotella and Porphyromonas, Fusobacterium, and Peptostreptococcus sp.)
• Aerobic and anaerobic beta lactamase-producing bacteria (BLP) were recovered from over a third of these patients.
• Methicillin-resistant S. aureus (MRSA) accounted for over 60% of S. aureus isolates.

Pseudomonas aeroginosa and other aerobic and facultative Gram-negative rods are frequently recovered in

• nasal sinuses,
• the immunocompromised host,
• individuals with human immunodeficiency virus infection, and
• cystic fibrosis.

The CRS infection evolves the formation of a biofilm that might play a significant role in the pathogenesis and persistence of CRS.

The microbiology of sinusitis is influenced by

• previous antimicrobial therapy,
• vaccinations, and
the presence of normal flora capable of interfering with the growth of pathogens.

Recognition of the unique microbiology of CRS and their antimicrobial susceptibility is of great importance when selecting antimicrobial therapy.

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