

## Comprehensive review on endonasal endoscopic sinus surgery

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### 1.2 Radiological diagnostic measures

An interpretation of the scans must generally take into consideration that

- CT scans reveal in up to 40% and
- MRI in >60%

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 Type and technique of endonasal sinus surgery

#### 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]. If older systems are used, video endoscopy provides poorer images than the direct view through the endoscope [177]; the time-loss in a nasal training model (touching different hidden spots) was increased [178].

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 ethmoidale as natural drainage pathway of the anterior ethmoid and the frontal sinus.

##### 2.5.3 Ethmoid sinus surgery

Ethmoid sinus surgery starts with uncinectomy, whereby the ethmoid infundibulum is opened (= infundibulotomy). The next and first 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.

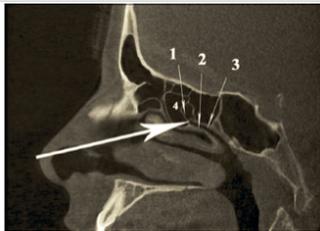


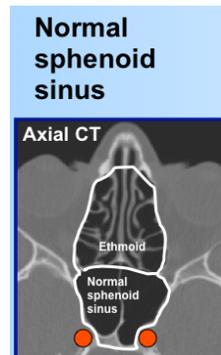
Figure 4: Sagittal CT demonstrating the surgical strategy to open the posterior ethmoid. After opening the basal lamella of the middle turbinate (1) directly above the horizontal part (2), the superior meatus (3) is reached. (4) = ethmoid bulla.

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 medial 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. Remaining below the level of the maxillary sinus roof, a lesion of the dorsal ethmoid roof is 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 speno-ethmoid cell with possibly prominent or exposed optic nerve. Afterwards, interventions of the sphenoid and the frontal sinuses may be performed.

##### 2.5.4 Sphenoid sinus surgery

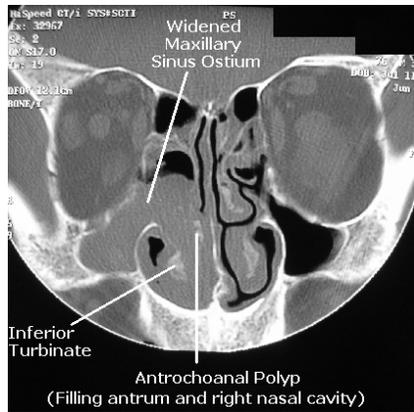


... Many authors resect few mm or the *caudal third of the superior turbinate* and consider this as unproblematic [275], [333], [340], [345], [346] even if a discrete interference with the sense of **smell** cannot be excluded theoretically [340]. There is just one scientific study addressing this problem.

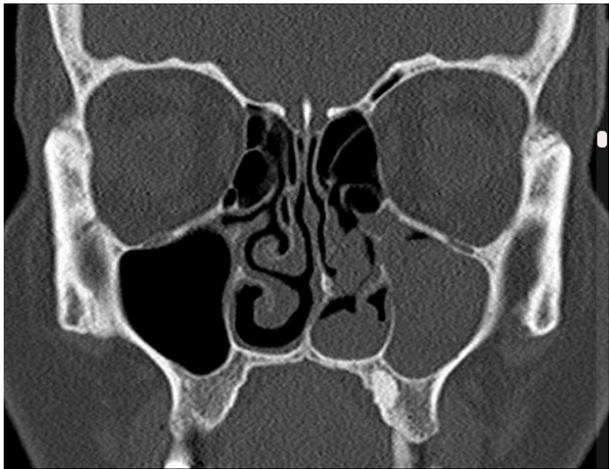
- Resection of the inferior part of the superior turbinate (inferior third or fourth) turned out not to be associated with smelling disorder even if in a sixth of the specimens olfactory tissue could be found. On the other hand, no olfactory tissue was found in the specimens of all patients with relevant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

... 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 sphenoid sinus and to avoid strictly any endangering of the internal carotid artery or the optic nerve. -->page 15

#### 4.4.1 Choanal polyp



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,  
<http://radiopaedia.org/>



From the case  
<http://radiopaedia.org/cases/15098>>rID: 15098</a>  
 left antrochoanal polyp



Computed tomography demonstrated a soft tissue mass that arises in the sphenoid sinus, widening the sphenoid-ethmoidal recess and extend to the left coana. In both floors of the maxillary sinuses are left sphenoidal polyp

*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 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 palatine,
- alveolar (Ventilations-), or prelacrima 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].

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 (= Eckzahngrube) [673],
- a prelacrima or
- postlacrima approach [293]

must be considered.

A usual approach via the inferior nasal meatus often does not provide sufficient overview of the whole maxillary sinus. This concerns mainly

- ACP that have a broad base or develop from several points, or
- cases with inflammatory component that make differentiation between thickened mucosa and the actual ACP difficult [672], [673].

The recurrence rates amount

- to totally 0–20% [674], [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 (0–8%) than in procedures exclusively via the middle meatus.

If after primary endonasal endoscopic complete removal of ACP it is not definitely obvious despite extended middle meatal antrostomy grade 4, there are two remaining options:

1. Terminating the intervention with an a priori uncertainty regarding the complete removal and acceptance of an increased risk of recurrence
2. Additional access via the canine fossa or prelacrima approach. Possible complications are a lesion
  - of branches of the infraorbital nerve,
  - of the teeth, or of the growth areas of the maxilla in children, or
  - of the nasolacrimal duct.

The according procedure should have been part of patient's informed consent preoperatively. In rare cases, the choanal polyp originates from the sphenoid sinus which requires the removal of the polypous base in the area of the sphenoid sinus ostium or in the sphenoid sinus in analogy to the antrochoanal polyp [686], [687].

#### 6.2 Improvement of single symptoms

- An improvement of olfaction is found less frequently in some more recent studies with 23–55% [1231], [1232], [1233] compared to earlier publications.
- 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].

These results indicate that a multifactorial pathophysiology can be suspected, e.g. an obstruction of the olfactory region and/or neuro-epithelial lesions. Normalization of olfaction is achieved more rarely. It is not possible to safely predict postoperative improvement [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].

#### 6.4 General and disease-related quality of life

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surgery

- improves bronchial asthma (in 76% of the patients with 85% less asthma attacks),
- reduces the number of inpatient treatments (by 64%), and the drug consumption (oral steroids by 73%, topical steroids by 29%, bronchodilators by 36%).
- The pulmonary function parameters do not change significantly [1244]

## 6.5 Recurrence

The reason for revision surgery is often a disturbed drainage of the frontal recess or the frontal sinus neostium caused by [15], [16], [17], [18], [362], [363], [391], [469], [1270], [1271]

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

A major part of those intraoperative findings in revision surgeries is based on an insufficient surgical technique applied for initial surgery [363].

A missed ostium sequence can lead to recirculation through both ostia [469], [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 are [19], [1218]:

- 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 or 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], [323], [1227], [1265], [1275], even if the study results are partly inconsistent [1218].
- Intolerance of analgesics [24], [1219], [1249], [1276], [1277], [1278], [1279], [1280] and Samter's triad (significantly more frequent revision surgery: 37% within 5 years and 89% within 10 years [1265]).
- Allergic fungal sinusitis [241], [1281].
- Evidence of staphylococcus infection with superantigens [1282], [1283], [1284], [1285], [1286], [1287], [1288], [1289] (see also complementary review by C. Bachert [201]).
- Evidence of biofilms [1290].
- So-called osteitis: A bone involvement with thickening of ethmoid trabeculae and walls of the paranasal sinuses 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 cortisone therapy by means of nasal rinsing can possibly compensate the negative influence [1298]. Suggested classification systems are not sufficiently validated [1291]. Currently it is unclear if it is a pathogenetic factor of the disease or mere a consequence [19], [1294], [1299] and which exact pathophysiological correlations exist [1291]. 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 sinus 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 [1300], 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 no contraindication for endoscopic sinus surgery [1300].
- The influence of allergic rhinitis on the surgical outcome is currently not clearly defined. It is recommended to preoperatively optimize therapy of the allergy in order to improve the postoperative result [1218], [1303].
- Tissue eosinophilia and histological parameters: An increased tissue eosinophilia (eosinophilia = state with more than normal eosinophils. eosinophils = white blood cells of the granulocyte type that have rough, round granules of cytoplasm that stain with eosin) correlates with a poorer surgical result and increases the risk of recurrence of CRSwNP [20], [209], [285], [1269], [1304], [1305], [1306], [1307]. 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].

Immunoodeficiency 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 secretion, for example via gastro-nasal 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** **W. Hosemann, C. Draf**

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#### **1 Preface**

... Furthermore, endonasal surgery has undergone an enormous expansion of its reach and its indications [40], [41] in specialized centers with continued development of 'simultaneous neuro-rhinology' [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:

- with regard to diffuse nasal polyposis surgery is often referred as generally "non-curative" [45].
- 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
  - intensive medical therapy [46] - [52].
- 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].

....

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

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].

Doubtlessly, 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:

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

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

- intra- or suprasellar hematomas,
- damages to the chiasma or
- injuries of the parasellar carotid artery,
- postoperative endocrine disorders,
- secondary bleeding of branches of the sphenopalatine artery, postoperative sphenoid sinusitis [101], [103].

Table 1: Complications of endonasal sinus surgery (based on: [62]).

Localization/overall type of injury	“minor complication”	“major complication”
Orbital complication	<ul style="list-style-type: none"> <li>Orbital emphysema</li> <li>Ecchymosis of the eyelid</li> </ul>	<ul style="list-style-type: none"> <li>Orbital hematoma</li> <li>Reduced visual acuity / blindness</li> <li>Enophthalmos</li> <li>Injury of the nasolacrimal duct</li> </ul>
Intracranial complication	<ul style="list-style-type: none"> <li>Uncomplicated CSF fistula</li> </ul>	<ul style="list-style-type: none"> <li>CSF leak</li> <li>(Tension-) pneumocephalus</li> <li>Encephalocele</li> <li>Brain abscess</li> <li>Meningitis</li> <li>Intracranial (subarachnoid) hemorrhage</li> <li>Direct injury of brain tissue</li> </ul>
Bleeding	<ul style="list-style-type: none"> <li>minor bleeding (stopped with nasal packing, no need for blood transfusion)</li> </ul>	<ul style="list-style-type: none"> <li>Injury of the ant. ethmoidal artery</li> <li>Injury of the sphenopalatine artery</li> <li>Injury of internal carotid artery</li> <li>Bleeding in need of transfusion</li> </ul>
other	<ul style="list-style-type: none"> <li>Synechia</li> <li>Slight exacerbation of pre-existing bronchial asthma</li> <li>Hyposmia</li> <li>Local infection (osteitis)</li> <li>Postoperative MRSA-infection</li> <li>Atrophic rhinitis</li> <li>Paraffinoma</li> <li>Myospherulosis</li> <li>Temporal irritation of the infraorbital nerve</li> <li>Hypoesthesia of the lip or teeth</li> </ul>	<ul style="list-style-type: none"> <li>“Toxic shock syndrome”</li> <li>Anosmia</li> <li>Severe exacerbation of a pre-existing bronchial asthma or bronchospasm</li> <li>Death</li> </ul>

**Begriffserklärung:**

emphysema: Eindringen von Luft  
 ecchymosis: kleinere Hautblutung  
 enophthalmos: Zurückziehen des Augapfels  
 CSF fistula: äußere Fistel der Subarachnoidalräume:  
 Anchoidea = Kurzbeiz für die zarte, gefäßarme, bindegewebige, beidseits endothelbedeckte mittlere Gehirn- u. Rückenmarkshaut  
 Synechia: fibröse Verklebung zweier normalerweise getrennter Gewebsschichten  
 Hyposmia: herabgesetzte Geruchsempfindung; s.a. Anosmie, Kakosmie  
 Anosmie: hochgradige Minderung bis Aufhebung der Geruchswahrnehmung, evtl. nur für bestimmte Riechstoffe (= elektive A. = Merosmie)  
 MRSA: multi-resistente staphylococcus aureus  
 atrophische Rhinitis: Gewebeschwund-bedingte Rhinitis  
 Rhinitis: Nasenschleimhautentzündung  
 Myospherulosis (also called spherulocytosis,[1]) is a foreign body-type granulomatous reaction to lipid-containing material and blood scarring: Schrumpfen

If data from the “beginning international phase” (“surgical innovation adoption curve” [85]) of endoscopic surgery (such as 1988 to 1998) is excluded, endoscopic surgery displays a comparable safe procedure according to the subsequent comparison of literature [80]. The complication rate has globally decreased slightly during the past few years [14].

The risk of a complication increases under the following circumstances [38], [39], [61], [62], [63], [68], [74], [76], [86], [87], [88], [89], [90], [91], [92]:

- Advanced sinus disease with the need of a more extensive approach.
- Revision surgery.
- Patients with severe comorbidities.
- Patients with anatomical abnormalities respectively missing anatomical landmarks.
- Increased risk of intraoperative bleeding.
- Lack of conception/manual experience of the surgeon.
- Surgical approaches from the right side (by a right handed surgeon).

Almost every one of the risk indicators mentioned in literature is subject to converse discussions:

- The elevated complication rate during larger interventions is partially disputed [39], [94].
- The increased risk during revision surgery is being questioned [72], [91], [94], in part initial surgeries are supposed to result in a higher rate of complications [86].
- The side preference is also being partially disclaimed [91].

**4 “Minor” complications**

**4.1 Damage of the lamina papyracea – orbital emphysema, preseptal bleeding**

**4.2 Uncomplicated bleeding of the mucosa**

**4.3 Uncomplicated liquorrhea**

In general, localized cerebrospinal fluid fistulas cannot always be avoided, even when the procedure is carried out very carefully [264].

**Epidemiology**

Small and isolated CSF fistulas, which are treated at once successfully, count statistically as “minor complication” [68].

- These particular incidents are not rare – in a survey 25% of American otorhinolaryngologists had experienced at least one unexpected CSF fistula intraoperative during the last 5 years [195].
- The rate of unexpected dura exposure is reported with a percentage of 0.2% [72].
- The number of minimal, temporary and occult leakage of cerebrospinal fluid ceasing spontaneously without clinical relevance, is significantly higher [196].
- According to literature the rate of manifest, clinical relevant CSF fistulas, is around 0.2–0.8% [72], [82], [91], [108], [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], [198], [199]; some studies state a percentage of 50% [193].
- There are even reports of CSF leaks which were diagnosed postoperatively after the patient had developed meningitis [200].

Every patient that complains of severe headaches needs to be examined thoroughly [76].

- Primarily nasal endoscopy is performed. Obvious nasal secretion is tested for beta 2 transferrin or beta-trace protein (prostaglandin H2 Delta isomerase) which is used as marker to diagnose liquorrhea [113], [197].
- High resolution computed tomography using thin sections in axial (sphenoid sinus, posterior wall of the frontal sinus) and coronal plane (rhinobasis) may detect
  - bony defects and
  - possibly air bubbles trapped intracranially or
  - even accumulated fluid [113], [201], [202].

... Regarding CT scans the quality of the image is crucial, reconstructed coronal planes frequently lead to misinterpretations [199], [209].

**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 75–80% the estimate of the size is correct [206], [210].

In individual cases subclinical fistulas were detected with fluorescein, neither with beta trace nor with beta 2 transferrin [217]. Nevertheless even fluorescein has a limited sensitivity (74%–96%).

False-negative samples may occur, among others, due to a temporary blockage of the fistula through

- blood clot,
- edematous mucosa,
- brain prolapsed or
- functional insufficient scars of mucosa.

In case of suspecting a false-negative result after injection, nasal packing is to remain for a certain amount of time, which later is checked for fluorescein [194].

**Surgical management**

Iatrogenic cerebrospinal fluid fistulas are usually below 3mm in size, in some cases 2–20 mm [192], [226], [227].

- Once a small cerebrospinal fluid leak is confirmed, references recommend conservative treatment to begin with [191], [195], [222], [228]. In a few cases lumbar drainage was solely carried out [215].
- However, 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.

This recommendation is based on observations in traumatology [229] and on experience that only in 1/3 of cases with conservative treatment the scar is rigid enough [228].

Closure of cerebrospinal fluid leaks via endoscopic endonasal approach belongs to the standard repertoire of sinus surgery. There are various approved techniques for repairing defects [205], [226], [230]. The choice of approach does not necessarily influence whether the rhinorrhea ceases when applying the usual diligence [191]. In general,

- free and pedicle flaps as well as
- autogenous, allogeneous or xenogeneous grafts

may be used.

Autogenous transplants include mucosa, bone, cartilage, fat, fascia or mucoperichondrium. For matter of stabilization gelatin, cellulose or fibrin glue may be prepared in different ways [231]. The initial exposition of the defect is important. The area of the skull base defect needs to be "cleared" 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 a valsalva maneuver (PEEP ventilation) [113]. For small defects free autogenous mucos grafts are preferred, the majority of surgeons place the graft in an onlay/overlay technique [191], [195], [222]. When forming a graft one can expect approximately 1/5 shrinkage, the borders of the defect need to overlap at least 4mm even in case of small leaks [222], [232]. The correct orientation and position of the free mucosa graft has to be carefully taken into account – otherwise an intracranial mucocele (-cele = Ansammlung) may develop [233].

Postoperatively the patient has to be closely monitored. Especially the state of consciousness needs to be mediated closely – in case of *loss of consciousness* a neurosurgical consult has to take place immediately. ... After the complication-prone procedure, a postoperative CT scan [76], [155] is appropriate. If an instrumental penetration into the intracranial space as part of the genesis of the CSF fistula could not be clearly excluded, a CT scan is performed emergently and mandatory.

Complementary treatment – antibiotics  
Complementary treatment – lumbar drains

#### Prognosis

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% [72], [191], [203], [212], [221], [226], [227], [244]. Recurrence of fistulas is frequently observed in patients with an increased CSF pressure [231].

Active CSF fistulas may result in meningitis.

- The cumulated risk for 10 years is indicated with 85%;
- in different case series it is rated at approx. 20% with an accumulation in the first couple of months [242], [246].
- This risk is reliably reduced to 0–1% long-term [221], [247].

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

headaches,  
seizures,  
secondary sinusitis,  
intracranial/subdural haemorrhages or abscesses,  
vision problems or  
cavernous sinus thrombosis [191], [221].

Postoperative olfactory dysfunctions, however, were reported with a considerably higher frequency in individual case series (17%) [239].

... In rhino-neurosurgery, the often extensively reconstructed dura represents a weak spot in the therapeutic concept. Originally, in up to 40% of the cases, postoperative fistulas were observed. This fact led, amongst others, to the introduction of the

**vascular** (of, characterized by, or containing cells or vessels that carry or circulate fluids, such as blood, lymph, or sap, through the body of an animal or plant)  
**pedicle** (a footlike, stemlike, or narrow basal part or structure, such as a narrow strip by which a graft of tissue remains attached to the donor site.)  
**intranasal mucoperiosteal flaps** (= flaps composed of mucous membrane and periosteum, as from the hard palate or gingiva)

and to a consistently multilayered defect closure. The result was a reduction to less than 5% cerebrospinal fluid fistulas (in individual cases to no less than 20%) [70], [102], [182], [223], [248], [249], [250].

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

- flow rate of cerebrospinal fluid,
- size of the defect and
- tissue texture,
- local dead space,
- kind and stability of the defect closure as well as
- patient-related factors, such as
  - recent radiotherapy,
  - diabetes,
  - renal insufficiency and
  - corpulence.

In the majority of cases, especially for postoperative persisting heavy flow of cerebrospinal fluid, revision surgery is advisable [182].

- Whilst "low-flow" cerebrospinal fluid fistulas can be operated with a delay after extended surgical procedures, i.e. within 7 days,
- "high-flow" liquor fistulas need to be operated immediately [251].

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 complications in time, e.g., [102], [261]

- infection,
- catheter defects,
- headaches,
- excessive drainage with irritation of the graft,
- pneumocephalus,
- subdural hematoma and
- neurological disorders.

#### 4.4 Synechia, "missed ostium sequence", unstable middle turbinate with lateralisation

- Occurring in about 10% of cases, synechia are frequent, however, in most cases (60–90%) functionally unapparent [72], [73], [94]. Hence, they are often not mentioned in statistics regarding complications [63], [76]. In other cases, symptomatic synechia with an incidence of 1–3% are documented [80], [98], [91], [274].
- 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 remains of the uncinate process, i.e. possibly overlooked intraoperative)
- The lateralization of the vertical lamella of the turbinate with its possible adverse effects, e.g. with regard to frontal or maxillary sinus drainage, has caused a long lasting discussion focusing on partial resection of the anterior middle turbinate as prevention [2], [100], [290], [291]. This may be performed especially in case of an evidently fractured or destabilized vertical lamella during surgery. Nevertheless, many authors approve of conserving the turbinate [185], [288], [292].
  - In individual cases, an "empty nose" syndrome has developed after resecting the middle nasal turbinate [293].
  - In contrast, no negative effects of a routine anterior 1/3 resection have been observed in a case series [294], [295], [296].
  - The rate of recurrent nasal polyposis was lower [297] and there was a tendency of improved olfactory function [298].
  - The number of lateral synechia also decreased, although the synechia developing during therapy in spite of partial resection were more challenging [299], [300], [301].

#### 4.5 Hyposmia

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 dorsal part of the roof of the nasal cavity
- and the adjoining parts of the nasal septum

In general, postoperative smell deficits may occur after direct mechanical trauma, after removal of olfactory mucosa accompanied by scarification of the latter, caused by a progressive inflammation of the mucosa or even by a postoperative modification 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 routine resections, there was no evidence of olfactory mucosa in the surgical specimens [314]. On the other hand, a complete postoperative anosmia was reported, following a resection of the superior nasal turbinate that was done by mistake [313]. Olfactory fibers 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 fibers, a hyposmia and no anosmia could be expected [315].

Preoperatively, about 17% of the routine patient population suffering from chronic rhinosinusitis is affected by olfactory disorders. After surgery, many of these patients can expect an improvement or a normalization. 16% of patients suffering from preoperative olfactory disorders were not aware of their impairment. For medico-legal reasons, these circumstances suggest that a preoperative measure of olfactory ability should always be performed. For rough orientation purposes, the rate of a postoperative arising hyposmia is indicated at about 3%, whilst the rate of a postoperative smell deterioration is estimated at about 9% [316], [317].

#### 4.6 Atrophic rhinitis

... an irritating crust formation, accompanied by a restricted nasal physiology, occurs in up to 33% of all cases [42], [102].

#### 4.7 Nerve injuries – infraorbital nerve, alveolar nerve

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.

... As a consequence, facial sensibility is affected postoperative [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 about 3% for all cases combined [72].

In justified individual cases of endonasal procedures, a complementary, localized *transoral puncture* of the maxillary sinus is recommended in order to *remove hyperplastic mucosa in hidden anatomical areas*, e.g. via insertion of a shaver [25], [328]. Only about 3% of patients benefit from this procedure, its use within the scope of polyposis is questionable [53], [328]. In an adverse case, a branch of the infraorbital n., above all the superior alveolar n. is damaged [288]. In 3/4 of all cases, complications occur postoperatively, such as cheek swelling, face pain, numbness of the face or teeth or even paresthesia. In about 30% of patients, these complaints remain in part permanently, most likely as a local dysesthesia [328].

... In ...

transpterygoid (Pterygoid ist ein Knochen der hinteren Gaumenregion)

... rhino-neurosurgical approach, amongst others, the maxillary or the vidian n. can be damaged [182]. Consequential effects of the latter lesion correspond to those of a vidian neurectomy which often leads to a 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 severe or-bital complications of vidian neurectomy. Recent literature only reports occasional cases of e.g., combined injuries of the local trigeminal n. and sympathetic n. with neurotrophic keratopathy, miosis and headaches after monopolar coagulation at the vidian n. [333].

#### 5 Severe or threatening complications

##### 5.1 Orbital haematoma

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

Injury of the anterior ethmoidal a.

The anterior ethmoidal a. can be easily injured during surgery of the anterior ethmoid.

Arteries at risk are those

- with a larger distance to the skull base,

- with bony dehiscences (dehiscence = pathologisches Auseinanderweichen zweier benachbarter Gewebestrukturen) or
- running within a ground lamella [398].

If the artery has been injured and is bleeding into the ethmoidal cavity,

- a bipolar (or monopolar with possible damage to the meninges) coagulation is generally used to stop the bleeding [113].
- Alternatively, clips are suggested, which, however, are not always effective, due to anatomical reasons [100], [402], [406].

*Injury of the posterior ethmoidal a.*

The distance between the anterior and the posterior ethmoidal artery is approximately 10–14 mm and the distance from the latter to the optic nerve as well as to the anterior wall of the sphenoid is about 8–9 mm [12]....

- In a coronal CT, a tip-like protrusion of the medial orbital wall at the location of the posterior ethmoidal a. can be seen in 66% of cases [405].
- An aplasia (Fehlbildung) of the artery may be observed in 2% to 34% of cases [404].
- in up to 30% of cases, a third ethmoidal a. is described [390], [403].

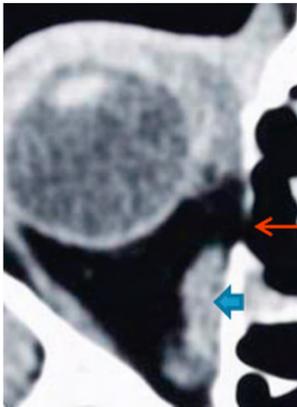
*Injury of the internal carotid a.*

The distance between the internal carotid a. and the optic nerve is 2–10 mm, ... The exact incidence rate of carotid injuries in paranasal sinus surgery is unknown. According to literature, carotid artery injuries occur with a rate of 0.3% in surgery of diffuse chronic rhinosinusitis [72].

### 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



**Figure 10:** Postoperative axial CT-scan of the left side showing destruction of the lamina papyracea (red arrow) and also complete transection of the medial rectus muscle in the course of routine paranasal sinus surgery (blue arrow: retracted stump of the muscle).

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 papyracea 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 papyracea with or without direct embedding of parts of the muscle [107], [450].

Other eye muscles are distinctly less often injured intraoperatively:

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], [76], [104], [363], [451], [452], [453].

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].

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

1. Partial or complete transection of the muscle.
2. Contusion with hematoma of the muscle tissue.
3. Impairment of the oculomotor n., e.g. at the point of transition between the middle and the dorsal third of the medial rectus muscle.
4. Prolapse 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 noticed intra-operatively by the surgeon [453]. 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 ophthalmic surgery, ocular functional deficits remain, although most of the patients (90%) are satisfied with their eye sight function in daily life [451], [455], [458]. The perforation in the lamina papyracea may be difficult to identify, even in postoperative imaging [17], [71], [363], [449], [459].

In other cases, motility limitations can be distinctly higher than the damage seen at imaging. Here, diffuse deformities, known as "fat adherence symptom" (see above) are assumed to evolve, together with a 'de-compartmentalization' of the extraocular fat tissue, followed by adhesions between the periorbit, fat, sclera and extraocular muscles [17]. After injuries caused by the shaver, chances to reconstruct the medial rectus muscle successfully are rather limited [340].

In rhino-neurosurgical operations, especially in the parasellar and suprasellar region (<http://medical-dictionary.thefreedictionary.com/sella>), in the area of the cavernous sinus or the clivus, thermal injuries or transections may lead to injuries of the abducens n. or the oculomotor n.. Frequently the oculomotor nerve recovers postoperatively from damages as long as the continuity of the nerve is preserved [102].

### 5.5 Enophthalmos

#### 5.6 Lacrimal duct injury, complications of endonasal dacryocystorhinostomy

Epiphora (Tränenaustritt) develops in about 0.1 to 1.7 % of cases after sinus surgery [71], [98], [480], [481]. Inapparent injuries of the lacrimal ducts are described in 3% of cases (in individual cases up to 15%). Under favorable circumstances, such cases correlate with an unintended dacryocystorhinostomy [480], [481], [482] (Figure 11). 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].

The effectiveness of endonasal dacryocystorhinostomy [Tränenabfluss-Chirurgie] is undisputed, experienced surgeons have a success rate of more than 85% [483], [484]

#### 5.7 Skull base injury, tension pneumocephalus, encephalocele [Hirnteile wölben sich nach außen]

... Symptoms are

- altered state of consciousness,
- restlessness,
- headache,
- nausea, vomiting,
- eye motility disorders,
- ataxia, and
- spasms.

If the underlying process is not interrupted,

- a pressure effect in the interhemispheric fissure (close to the motor cortex) might induce a diplegia [paralysis affecting symmetrical parts of the body].
- Additionally rupture of bridging veins may cause
  - subdural hematomas and
  - finally cardiac arrest [251], [491], [492], [493].

... 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], [496].

#### 5.8 Meningitis, brain abscess, intracranial haemorrhage

**Meningitis, brain abscess [umschriebene Eiteransammlung im Gehirn nach durch Entzündung bedingtem Untergang u. Verflüssigung („Einschmelzung“) von Hirngewebe]**

Postoperative meningitis is rare, although it represents the most frequent intracranial complication in paranasal sinus surgery. It spreads through

- dural lesions,
- perivascular or vascular paths or
- even via perineural spaces of the olfactory fibers [90].

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

- a history of craniotomy or endonasal surgery,
- surgery with high degree of difficulty,
- preexisting external ventricular drainage or ventriculoperitoneal shunt,
- cerebrospinal fluid fistula postoperatively.

On the contrary earlier irradiation, the patient's age, pathology, or the duration of a lumbar drainage do not affect the rate of meningitis. Most studies imply that prophylactic administration of antibiotics does not reduce the risk of meningitis or brain abscess in skull base surgery [503].

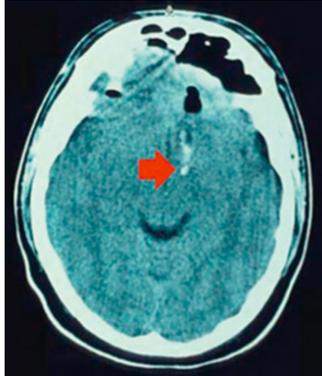
#### **Subdural hematoma, cerebral hemorrhage, ischemia**

Uncomplicated cerebrospinal fluid fistulas ... may lead to severe complications, e.g. by means of suction of tissue into the skull base defect,

- causing bleeding of intradural or subarachnoid vessels or from branches of the anterior cerebral a. or the anterior ethmoidal a.
- Additionally this may result in
  - an epidural, subdural or intracerebral haematoma,
  - a localized cerebral infarction or
  - even a traumatic aneurysm [90], [91], [517], [517] [aneurysma = griech. Ausdehnung. Aneurysma v.a. der basalen Arterien des Gehirnkreislaufs. Klinisch oft stumm oder paralytisch v.a. bei Störung der Hirnerven; bei Einriss erfolgt (bisweilen mit apoplektiformen Symptomen) Subarachnoidalblutung bzw. Hirnblutung (intrazerebrales Hämatom)].

Instantaneous fatal bleeding can possibly occur due to an injury of the internal carotid a., the anterior cerebral a. or the anterior communicating a. Serious damage can also be triggered by induced arterial spasms [90]. The defect at the skull base can cause a secondary herniation of brain tissue [518]. An iatrogenic encephalocele can develop slowly within months and might only become apparent though meningitis [200]. After extensive reconstruction of the frontobasal region and after a large amount of CSF has been discharged, intracranial pressure may drop, which in turn can result in displacement of the graft or tension on the bridging veins causing a subdural haematoma. For these reasons, a lumbar drainage is contraindicated in case of a prominent pneumocephalus. After extensive surgical procedures, a CT control must be performed on the first or second postoperative day [251].

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



**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 aneurysm 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 [520], [521]. 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).

#### **5.10 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].

#### **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]

- In rhino-neurosurgical surgery, anosmia may be an inevitable consequence due to tumour resection e.g. in the olfactory fossa –
- in other cases it results from generous resection of turbinate or mucosa [182].

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#### **Nationwide incidence of major complications in endoscopic sinus surgery.**

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#### **BACKGROUND:**

Endoscopic sinus surgery (ESS) is one of the most commonly performed procedures in otolaryngology. Major complications are estimated to occur in 1-3% of cases, based on early studies with 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.

#### **METHODS:**

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 requiring blood transfusion-were identified by searching the database for related International Classification of Diseases, 9th edition (ICD-9) and Current Procedural Terminology (CPT) codes. Complication rates were examined and time to occurrence analyzed. Two-tailed test of proportions, global chi-square test, and logistical regression analysis were used for statistical comparison.

#### **RESULTS:**

A total of 62,823 patients who met rigorous inclusion criteria were included. The overall major complication rate was 1.00%

- CSF leak 0.17%;
- orbital injury 0.07%; (Augenhöhle, d.h. Knochen)
- hemorrhage requiring transfusion 0.76%.

CSF leak was less likely to occur in the pediatric population ( $p = 0.05$ ), whereas orbital injury was more likely to occur in children ( $p < 0.001$ ).

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

#### **CONCLUSION:**

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 design limitations did not allow for comprehensive assessment of IGS in the development of these complications. These data help to educate otolaryngologists and patients about complication rates in ESS in a modern context.

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#### **Objective olfactory outcomes after revision endoscopic sinus surgery.**

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#### **Abstract**

#### **BACKGROUND:**

Patients who suffer from hyposmia and anosmia report a negative effect on their overall quality of life. Smell disturbance of patients with chronic rhinosinusitis (CRS) can improve after endoscopic sinus 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), especially by objective measurements, is still lacking.

#### **METHODS:**

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

identification test (SIT) score. Olfactory outcomes from anosmia to hyposmia/normosmia, or from hyposmia to normosmia, were considered as "improvement." Postoperative assessments were divided into two periods: period 1 (P1) is defined as >6 but <12 months postoperatively; period 2 (P2) is defined as >12 but <24 months postoperatively.

#### RESULTS:

Thirty-two patients with smell disturbance preoperatively (period 0 [P0]) and confirmed by UPSIT-TC were enrolled into this study. Mean SIT score at P0 was 13.3; mean SIT score at P1 was 18.6; mean SIT score at P2 was 20.4. The presence of nasal polyps blocking the olfactory cleft were associated with better olfaction improvements ( $p < 0.05$ ) as was the degree of mucosal swelling. The overall improvement rates were 44.8 and 47.8% at P1 and P2, respectively.

#### CONCLUSION:

RESS resulted in objective evidence of olfactory improvement in approximately one-half of our cohort over 16 months of follow-up and offers a treatment option for an otherwise poor prognosis condition.

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#### Olfactory improvement after endoscopic sinus surgery.

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#### PURPOSE OF REVIEW:

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.

#### RECENT FINDINGS:

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.

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Free PMC Article

Early studies supported the role of ESS to improve CRS-related olfactory dysfunction<sup>23–29</sup>. 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 2009, Litvack et al. reported a prospective trial of 111 patients with olfactory impairment undergoing ESS for medically refractory CRS<sup>30</sup>. 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.

They hypothesized that

anosmic patients typically had a mechanical obstruction to the olfactory cleft which was amenable to surgical removal  
hyposmic patients which likely suffered from a multi-factorial etiology of olfactory impairment with chronic neuroepithelial inflammation and damage which was less amenable to ESS optimization.

The only predictive factor for post-ESS olfactory improvement was the presence of nasal polyposis.

Factors such as

- age,
- allergy status,
- ASA intolerance, and
- history of prior ESS

were not predictive factors.

A large prospective 2008 study by Pade et al. evaluated 206 patients with olfactory impairment who elected ESS for CRS31. They demonstrated that

- 23% of patients received improvement,
- 68% received no change, and
- 9% got worse after ESS.

The results suggested that the presence of nasal polyposis and eosinophilia predicted olfactory improvement

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 CRS10.

- They demonstrated that ESS had no impact on olfactory improvement.

In a subsequent 2009 article by Jiang et al. they attempted to identify predictive factors for olfactory improvement following ESS<sup>32</sup>. The results demonstrated no predictive correlation between olfactory improvement following ESS and the

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

In 2010, Soler et al. evaluated the impact of histologic markers on olfactory outcomes following ESS<sup>33</sup>.

- They identified that olfactory impairment correlated with higher degrees of tissue eosinophilia and basement membrane 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. [Am J Rhinol Allergy. 2010]
- Does olfactory function improve after endoscopic sinus surgery? [Otolaryngol Head Neck Surg. 2009]
- [Assessment of olfactory disturbances in the patients with rhinosinusitis and polyp nasi treated by endoscopic sinus surgery]. [Pol Merkur Lekarski. 2010]

*Rhinology*. 2016 Mar 2. [Epub ahead of print]

#### Defining appropriateness criteria for endoscopic sinus surgery during management of uncomplicated adult chronic rhinosinusitis: a RAND/UCLA appropriateness study.

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#### INTRODUCTION:

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 polyps.

For adult patients with uncomplicated CRS **with** nasal polyps, ESS can be appropriately offered when

- the CT Lund-Mackay score is  $\geq 1$  and

- there has been a minimum trial of a topical intranasal corticosteroid +
- a **short-course** of systemic **corticosteroid** with a post-treatment total Sino Nasal Outcome Test (SNOT-22) score  $\geq 20$

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

- the CT Lund-Mackay score is  $\geq 1$  and
- there has been a minimum trial of a topical intranasal corticosteroid +
- either
  - 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  $\geq 20$ .

#### CONCLUSIONS:

This study has developed and reported of 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 threshold 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 for 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.

#### Causes of failure in endoscopic frontal sinus surgery in chronic rhinosinusitis patients

Valdes CJ, Bogado M, Samaha M

Article in *International Forum of Allergy and Rhinology* 4(6) · June 2014 with 57 Reads

Impact Factor: 2.37 · DOI: 10.1002/air.21307

1Department of Otolaryngology-Head and Neck Surgery, Hospital del Salvador, Universidad de Chile, Santiago, Chile.

**KEYWORDS:** chronic rhinosinusitis (CRS); endoscopic sinus surgery (ESS); frontal sinus surgery (FSS); recalcitrant frontal sinusitis; revision surgery

#### BACKGROUND:

The frontal sinus is the most challenging area to address in endoscopic sinus surgery (ESS). Incomplete surgery or iatrogenic injury in the narrow space of the frontal recess with synechia formation can lead to recurrence or persistence of disease. The goal of this study was to identify causes of failure of endoscopic frontal sinus surgery and to determine complication rates.

#### METHODS:

A cross-sectional retrospective study was conducted. Charts and preoperative sinus computed tomography (CT) scans of patients who underwent revision frontal ESS for chronic frontal rhinosinusitis, between 2006 and 2012 were reviewed.

#### RESULTS:

Of 829 patients who underwent ESS during the study period, 740 had the frontal recess dissected and frontal sinus opened. Of these,

- 66 patients had revision surgery of the frontal sinus, with a total of 109 frontal sinuses.
- The mean  $\pm$  standard deviation (SD) age was  $52 \pm 12.9$  years.
- 40 patients were male (59.1%).

The 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 scarring of the middle turbinate (47.7%);
- residual anterior ethmoid air cell (32.1%); and
- residual frontal cells (24.8%).

#### CONCLUSION:

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

Cochrane Database Syst Rev. 2014;12:CD006991. doi: 10.1002/14651858.CD006991.pub2. Epub 2014 Dec 1.

#### Surgical versus medical interventions for chronic rhinosinusitis with nasal polyps.

Rimmer J1, Fokkens W, Chong LY, Hopkins C.

Author information

1ENT Department, Guy's Hospital, London, UK. rimmer.joanne@gmail.com.

#### Abstract

#### BACKGROUND:

Nasal polyps cause nasal obstruction, discharge and reduction in or loss of sense of smell, but their aetiology is unknown. The management of chronic rhinosinusitis with nasal polyps, aimed at improving these symptoms, includes both surgical and medical treatments, but there is no universally accepted management protocol.

#### OBJECTIVES:

To assess the effectiveness of endonasal/endoscopic surgery versus medical treatment in chronic rhinosinusitis with nasal polyps.

#### SEARCH METHODS:

We searched

- the Cochrane Ear, Nose and Throat Disorders Group Trials Register;
- the Cochrane Central Register of Controlled Trials (CENTRAL);
- PubMed;
- EMBASE;
- CINAHL;
- Web of Science;
- Cambridge Scientific Abstracts;
- ICTRP and
- additional sources

for published and unpublished trials. The date of the search was 20 February 2014.

#### SELECTION CRITERIA:

Randomised controlled trials of any surgical intervention (e.g. polypectomy, endoscopic sinus surgery) versus any medical treatment (e.g. intranasal and/or systemic steroids), including placebo, in adult patients with chronic rhinosinusitis with nasal polyps.

#### DATA COLLECTION AND ANALYSIS:

We used the standard methodological procedures expected by The Cochrane Collaboration. Meta-analysis was not possible due to the heterogeneity of the studies and the selective (incomplete) outcome reporting by the studies.

#### MAIN RESULTS:

4 studies (231 participants randomised) are included in the review. No studies were at low risk of bias. The studies compared 3 comparison pairs:

- (1) endoscopic sinus surgery (ESS) versus systemic steroids (1 study,  $n = 109$ ),
- (2) polypectomy versus systemic steroids (2 studies,  $n = 87$ );
- (3) (ESS + topical steroid) versus (antibiotics + high-dose topical steroid) (1 study,  $n = 35$ ).

All participants also received topical steroids but doses and types were the same between the treatment arms of each study, except for the study using antibiotics. In that study, the medical treatment arm had higher doses than the surgical arm. In 2 of the studies, the authors failed to report the outcomes of interest. Although there were important differences in the types of treatments and comparisons used in these studies, the results were similar.

#### PRIMARY OUTCOMES:

symptom scores and quality of life scores

There were no important differences between groups in either the patient-reported disease-specific symptom scores or the health-related quality of life scores. Study 3 and study 1 failed to find a difference in generic health-related quality of life scores. The quality of this evidence is low or very low.

Endoscopic scores and other secondary outcomes

2 studies reported endoscopic scores.

- Study 1 reported a large, significant effect size in the surgical group, with a mean difference (MD) in score of  $-1.5$  (95% confidence interval (CI)  $-1.78$  to  $-1.22$ ,  $n = 95$ ) on a scale of 0 to 3 (0 = no polyposis, 3 = severe polyposis).

- 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. PMID: 25437000 [PubMed - indexed for MEDLINE]

Otolaryngol Head Neck Surg. 2007 Oct;137(4):555-61.

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

Hopkins C1, Browne JP, Slack R, Lund V, Brown P. 1Clinical Effectiveness Unit, Royal College of Surgeons of England, London. clairehopkins@yahoo.com

#### 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.

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PMCID: PMC3977600

NIHMSID: NIHMS511378

#### Sino-nasal Outcome Test (SNOT-22):

##### A predictor of post-surgical improvement in patients with chronic sinusitis

copy with Supplements

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\*Co-first authors

**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)

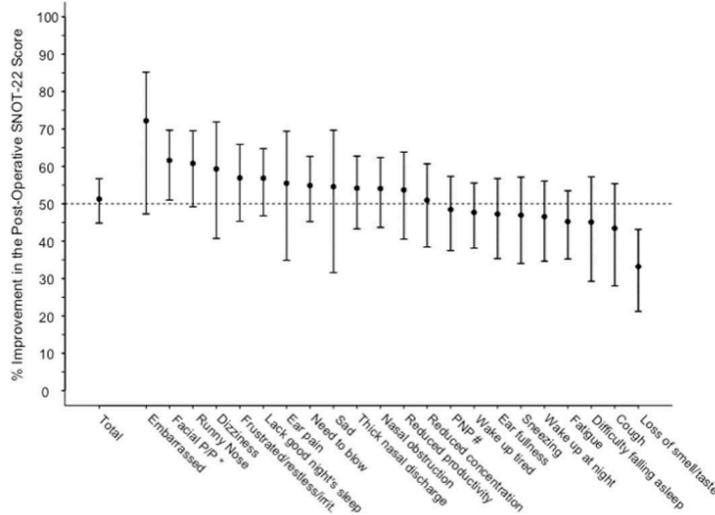
were obtained for each subject and analyzed for correlation with surgical outcomes.

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



\*P/P: Pain/Pressure; # PND: Post-nasal Drip

Figure 1. Univariate Analysis of Post-operative Improvement in SNOT-22 Scores by Question  
Abbreviations: PP - pain/pressure (\*), PND - post-nasal drip (#).

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<sup>15</sup>

ACCEPTED MANUSCRIPT

Figure S1. Sino-Nasal Outcome Test-22 Questionnaire

A: Considering how severe the problem is when you experience it and how frequently it happens, please rate each item below on how bad it is by circling the number that corresponds with how you feel using this scale: 0 = No problem, 1 = Very mild problem, 2 = Mild or slight problem, 3 = Moderate problem, 4 = Severe problem, 5 = Problem as bad as it can be

	No problem	Very mild problem	Mild or slight problem	Moderate problem	Severe problem	Problem as bad as it can be
1. Need to blow nose	0	1	2	3	4	5
2. Sneezing	0	1	2	3	4	5
3. Runny nose	0	1	2	3	4	5
4. Cough	0	1	2	3	4	5
5. Post nasal discharge (severe)	0	1	2	3	4	5
6. Thick nasal discharge	0	1	2	3	4	5
7. Ear fullness	0	1	2	3	4	5
8. Dizziness	0	1	2	3	4	5
9. Ear pain	0	1	2	3	4	5
10. Facial pain/pressure	0	1	2	3	4	5
11. Difficulty falling asleep	0	1	2	3	4	5
12. Waking up at night	0	1	2	3	4	5
13. Lack of a good night's sleep	0	1	2	3	4	5
14. Waking up tired	0	1	2	3	4	5
15. Fatigue	0	1	2	3	4	5
16. Reduced productivity	0	1	2	3	4	5
17. Reduced concentration	0	1	2	3	4	5
18. Frustrated/irritable	0	1	2	3	4	5
19. Sad	0	1	2	3	4	5
20. Embarrassed	0	1	2	3	4	5
21. Sense of smell/taste	0	1	2	3	4	5
22. Blockage/congestion of nose	0	1	2	3	4	5

TOTAL: \_\_\_\_\_

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Table S1. Summary for the post-operative improvement in the mean Snot22 questionnaire score unadjusted for the baseline score.

Question	Estimate % Improvement in Mean Score	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Total	51.1	44.8	56.7
Embarrassed	72.1	47.3	85.2
Facial P/P	61.4	51.0	69.7
Runny Nose	60.6	49.2	69.5
Nasal Obstruction	59.2	40.7	71.9
Frustrated/restless/irritable	56.8	45.3	65.9
Lack of a good night's sleep	56.7	46.8	64.8
Ear pain	55.4	34.9	69.4
Need to blow nose	54.8	45.2	62.7
Sad	54.4	31.6	69.7
Thick nasal discharge	54.0	43.3	62.7
Loss of smell/taste	53.9	43.7	62.3
Reduced productivity	53.6	40.5	63.8
Reduced concentration	50.8	38.5	60.7
PNP	48.3	37.5	57.3
Wake up tired	47.5	38.1	55.5
Ear fullness	47.1	35.4	56.7
Sneezing	46.8	34.0	57.1
Wake up at night	46.4	34.7	56.1
Fatigue	45.1	35.2	53.5
Difficulty falling asleep	45.0	29.3	57.2
Cough	43.3	28.0	55.4
Loss of smell/taste	33.1	21.2	43.1

Am J Rhinol. 2002 Nov-Dec;16(6):313-7.

Significance of eosinophilia in chronic rhinosinusitis.

Zadeh MH<sup>1</sup>, Banthia V, Anand VK, Huang C.

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 (84% versus 32%), and
- revision ESS (84% 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

chronicity of disease.

PMID: 12512905 [PubMed - indexed for MEDLINE]

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[Int Arch Allergy Immunol](#). 2008;146 Suppl 1:77-81. doi: 10.1159/000126066. Epub 2008 May 27.

**Chronic rhinosinusitis: risk factors for the recurrence of chronic rhinosinusitis based on 5-year follow-up after endoscopic sinus surgery.**

Matsuwaki Y, Ookushi T, Asaka D, Mori E, Nakajima T, Yoshida T, Kojima J, Chiba S, Ootori N, Moriama H.

**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,
- peripheral eosinophilia of at least 520 cells/microl,
- peripheral eosinophil count,
- total IgE,
- presence of polyps,
- CT score,
- presence of fungi (positive fungal culture or stain),
- mucus or mucosal eosinophilia,
- mucosal 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/microl or more and those with asthma were likely to experience recurrence of CRS within 5 years after surgery.
2. Furthermore, patients with mucus or mucosal eosinophilia who were diagnosed as having eosinophilic CRS (E CRS) showed a high incidence of recurrence within 5 years. The parameter of mucus or mucosal eosinophilia (diagnosis of E CRS) had a positive predictive value of 85.7%.

**CONCLUSIONS:**

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

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PMID: 18504412 [PubMed - indexed for MEDLINE]

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[Laryngoscope](#). 2007 Nov;117(11):2036-40.

**Eosinophilic bacterial chronic rhinosinusitis.**

Ferguson RJ, Seethala R, Wood WA.

**BACKGROUND:**

A subset of Chronic Rhinosinusitis (CRS) patients are those with eosinophilic CRS (E CRS). 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 E CRS, defined as the presence of fungi in the eosinophilic mucin of CRS, has been proposed as causal in many cases. Other proposed causes of E CRS include bacterial superantigen induction of inflammation and aspirin sensitivity.

**DESIGN:**

Retrospective review.

**METHODS:**

Histopathology from patients with previously diagnosed E CRS was prospectively re-reviewed for bacterial and fungal presence and correlated with patients' demographic data. The study population was comprised of 55 specimens with E CRS from 34 patients, over a 3-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 E CRS specimens. Specimens with fungal colonization were more often associated with bacterial presence than without bacteria (17 of 22 [77%] vs. 5 of 22 [23%],  $P < .02$ ).

**CONCLUSION:**

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 superantigen. Other possible reasons for the high rate of bacterial and fungal colonization of E CRS include increased pathogen exposure, or failure to eliminate pathogens.

PMID: 17767091 [PubMed - indexed for MEDLINE]

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[Laryngoscope](#). 2013 May;123(5):1070-4. doi: 10.1002/lary.23721. Epub 2013 Apr 2.

**Eosinophilic rhinosinusitis is not a disease of ostiomeatal occlusion.**

Sridwongs K, Chin D, Sacks R, Earls P, Harvey RJ.

1Australian School of Advanced Medicine, Macquarie University, Sydney, Australia. drkornkiat@yahoo.com

**OBJECTIVES/HYPOTHESIS:**

Ostiomeatal complex (OMC) occlusion may play a role in the pathogenesis of some chronic rhinosinusitis (CRS) subgroups, but its role in diffuse mucosal inflammation is strongly debated. The association between radiological OMC occlusion and its draining sinuses in patients with eosinophilic rhinosinusitis (E CRS) compared to non-E CRS is investigated.

**STUDY DESIGN:**

Case-control study.

**METHODS:**

Patients with CRS who underwent endoscopic sinus surgery were investigated. Preoperative computed tomography scans were evaluated. Structured histopathology reporting was performed. The study group was patients with high tissue eosinophil  $>10$ /high power fields (HPF), and the control group was patients with low tissue eosinophil  $\leq 10$ /HPF. The radiological relationship of OMC occlusion to the draining sinuses was analyzed in each group.

**RESULTS:**

70 patients with a mean age of  $49.7 \pm 14.1$  years were analyzed.

41 (58.6%) patients had high tissue eosinophil  $>10$ /HPF.

- All patients with E CRS had maxillary disease, and there were 36.2% without OMC occlusion.
- There was no association of OMC occlusion to
  - either the anterior ethmoid (E CRS: odds ratio [OR], 1.84; 95% confidence interval [CI], 0.24-14.14;  $P = .55$ ; non-E CRS: OR, 1.57; 95% CI, 0.34-7.33;  $P = .56$ ) or
  - frontal sinuses (E CRS: OR, 0.67; 95% CI, 0.12-3.82;  $P = .65$ ; non-E CRS: OR, 1.58; 95% CI, 0.45-5.54;  $P = .47$ ).

For patients with non-E CRS, maxillary sinus diseases was present in

- 96.2% of those with OMC occlusion and
- 50% of those without (OR, 25.0; 95% CI, 2.77-226.08;  $P < .001$ ).

**CONCLUSIONS:**

OMC occlusion is not associated with draining sinuses for patients with E CRS.

Simple surgical interventions directed at the OMC are unlikely to be of benefit to this CRS subgroup.

**LEVEL OF EVIDENCE:**

3b.

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PMID: 23553255 [PubMed - indexed for MEDLINE]

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Mayo Clin Proc. 2011 May; 86(5): 427-443.

doi: 10.4065/mcp.2010.0392

**Rhinosinusitis Diagnosis and Management for the Clinician: A Synopsis of Recent Consensus Guidelines**

Eli O. Meltzer, MD and Daniel L. Hamilos, MD

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PMCID: PMC3084646

## Eosinophilic Surgery

Nasal Polyps

<http://www.mayoclinic.org/diseases-conditions/nasal-polyps/basics/definition/con-20023206>

<http://www.mayoclinic.org/symptoms/loss-of-smell/basics/causes/sym-20050804>

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*Int J Clin Exp Med*. 2014 Jun 15;7(6):1585-91. eCollection 2014.

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

Shen B<sup>1</sup>, Liu LT<sup>2</sup>, Liu D<sup>2</sup>, Guo QY<sup>2</sup>, Dong P<sup>1</sup>.

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<sup>2</sup>Department of Otolaryngology, Weifang People's Hospital Weifang 261041, China.

40 patients were randomly assigned to two groups to undergo different surgical method.

- one is radical FESS (RFESS), was to remove nasal polyposis (NP) and open all paranasal sinuses related with inflammation, while
- the other is conservative FESS (CFESS), with the purpose of
  - ensuring nasal ventilation and drainage, as well as
  - obviating the lesion of nasal mucosa, which was
  - just to remove nasal polyposis and
  - open maxillary sinuses and/or anterior ethmoidal sinuses related with inflammation.

We have evaluated all the scores of CT, SF-36 and SNOT-20 between the two groups preoperatively. The scores are no significantly difference in all of the questionnaires. Postoperative, the two groups

- both have made great improvement in patients' QOL and symptoms, but
- there was no statistical significance in scores of QOL and SNOT-20 between the two groups.
- the improvement extents of nasal obstruction and reduction of smell were similar.

Then, we inferred that CFESS would

- reach the level of curing/ameliorating the QOL and symptoms of patients with CRS. Furthermore, we believed that
- much more physiological function has been protected and
- the patients would feel better than RFESS group in a long-term followup,

on account of nasal structure and nasal mucosa were more conserved by CFESS.

Apart from them, CFESS could stave off subsequent complications, such as cerebrospinal rhinorrhea, orbit cardboard damage and optic nerve injury.

*Am J Rhinol Allergy*. 2016 Mar;30(2):143-8. doi: 10.2500/ajra.2016.30.4271.

### Extensive versus functional endoscopic sinus surgery for chronic rhinosinusitis with nasal polyps and asthma: A 1-year study.

Chen FH<sup>1</sup>, Deng J, Hong HY, Xu R, Guo JB, Hou WJ, Sun YQ, Lai YY, Li HB, Shi JB.

Author information

#### BACKGROUND:

Functional endoscopic sinus surgery (FESS) is considered to be the standard procedure for chronic rhinosinusitis with nasal polyps (CRSwNP). However, for CRSwNP that accompanies asthma, the results are not satisfying. Extensive endoscopic sinus surgery (EESS) aimed at reducing the inflammatory load has been indicated as a viable option for refractory chronic rhinosinusitis.

#### OBJECTIVE:

To evaluate the clinical outcomes and safety of EEES (middle turbinate and superior turbinate resection and total ethmoidectomy) for patients with CRSwNP and with asthma.

#### METHODS:

This was a prospective, single-institute cohort study conducted in a tertiary teaching hospital. Patients with CRSwNP and with asthma who were proceeding to surgery were enrolled. There were 23 patients in the EEES group and 24 patients in the FESS group. The preoperative disease severity was evaluated by the visual analog scale (VAS), Lund-Kennedy (L-K) endoscopy score, computed tomography Lund-Mackay score, asthma control test (ACT), and pulmonary function test. Clinical outcomes were comparatively evaluated between the two groups after a 1-year follow-up by using the VAS score, the postoperative endoscopic score (E score), L-K score, ACT score, and pulmonary function test.

#### RESULTS:

The disease severity (general VAS score, endoscopic L-K score, computed tomography score, ACT score) showed no significant differences between the two groups before surgery ( $p > 0.05$ ). One year after surgery, both groups achieved significant improvement in the VAS score and endoscopic L-K score. The EEES group showed better improvement in the olfactory VAS score and E score compared with the FESS group (mean [standard deviation] change of olfactory VAS,  $6.00 \pm 3.67$  versus  $3.30 \pm 3.44$ ,  $p = 0.015$ ; mean [standard deviation] E score,  $0.31 \pm 0.18$  versus  $0.66 \pm 0.26$ ,  $p < 0.001$ ).

No significant differences between the two groups ( $p > 0.05$ ) were found in the change of

- general nasal symptom VAS score,
- other individual VAS scores (nasal congestion, discharge, headache and/or facial pain),
- L-K score,
- ACT score, and
- pulmonary function

#### CONCLUSION:

EEES for patients with CRSwNP and with asthma may help to improve the subjective olfaction and endoscopic appearance.

PMID: 26980396 [PubMed - in process]

Michael Reiss,

Facharztwissen HNO-Heilkunde: Diagnostik und Therapie, 2009

#### Anatomy and relevant anatomical variants in nasal and paranasal sinuses CT scan

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<div style="width:546px"> <strong style="display:block;margin:12px 0 4px"><a href="http://slideplayer.com/slide/6014052/" title="Anatomy and relevant anatomical variants in nasal and paranasal sinuses CT scan P. Loubeyre 1 MD & J.S Lacroix 2 MD, PhD 1 Radiology Department, 2 Rhinology-Olfactology." target="\_blank">Anatomy and relevant anatomical variants in nasal and paranasal sinuses CT scan P. Loubeyre 1 MD & J.S Lacroix 2 MD, PhD 1 Radiology Department, 2 Rhinology-Olfactology.</a></strong><iframe src="http://player.slideplayer.com/20/6014052/" width="546" height="460" frameborder="0" marginwidth="0" marginheight="0" scrolling="no" style="border:1px solid #CCC;border-width:1px 1px 0 #allowfullscreen></iframe><div style="padding:5px 0 12px">View more presentations from <a href="http://slideplayer.com/user/7165957/" target="\_blank">Francis Edwards</a> </div> </div>

	Anatomic variants
Sinusitis – Imaging technique (3-10)	Septal deviation (dia 40)
Paranasal sinuses (dia 11-12)	Septal spurs (dia 41)
Ostiomeatal unit (dia 13-16)	Middle turbinate (dia 42-44)
Uncinate process (dia 17-19)	Superior turbinate (dia 45)
Ethmoid bulla (dia 20-22)	Uncinate process (dia 46)
Middle turbinate (dia 23,24)	Frontal bulla cell (dia 47)
Ethmoid infundibulum (dia 25)	Frontal sinus extension (dia 48)
Frontal recess (dia 26-28)	Agger nasi cell (dia 49)
Sphenothmoidal recess (dia 29,30)	Maxillary sinus recesses (dia 50)
Posterior nasal fontanel (dia 31)	Sphenoid sinus recesses (dia 51-53)
Posterior choana (dia 32)	Intersinus sphenoid septation (dia 54)
Nasal septum (dia 33)	Surgical risks
Nasolacrimal duct (dia 34)	Vulnerability of the carotid canal (dia 55-57)
Anterior skull base (dia 35-38)	Vulnerability of the optic nerve (dia 58-61)
	Vulnerability of the orbit (dia 62-65)
	Vulnerability of the nasolacrimal duct (dia 66)
	Vulnerability of anterior skull base (dia 67)

*Curr Opin Allergy Clin Immunol*. 2006 Feb;6(1):29-36.

### The role of sinus disease in asthma.

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#### Abstract

##### PURPOSE OF REVIEW:

Some time ago, a link between upper and lower respiratory disease was described, which gave rise to the concept of 'united airways disease'. This concept primarily refers to the well established link between allergic rhinitis and asthma, but it also covers a possible link between sinus disease and asthma (allergic or nonallergic) and other lower airway disease.

## 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 remodelling markers,

however, were recently described to differentiate nasal polyposis from CRS, yielding two discrete entities.

These patterns resemble 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 deficits in the clinical classification and in basic knowledge of pathophysiological pathways. Recent research into upper airway and sinus inflammation and remodelling may reveal new perspectives and lead to a classification of sinus disease, which will facilitate appropriate clinical and epidemiological studies.

PMID: 16505609 [PubMed - indexed for MEDLINE]

## 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 **corticosteroid dependent asthmatic** patients,[34] about 70% of all participants reported symptoms of rhinosinusitis. The **total symptom score**, however, was significantly higher

- in patients with severe steroid dependent asthma
- than in those with mild-to-moderate asthma.

In this study

- the **entire** corticosteroid dependent (severe asthmatic) group had **abnormal CT** scans,
- as compared with about **90%** of the mild-to-moderate asthmatic group.

Another study,[35] however,

- demonstrated **CT scan abnormalities** in about 84% of the severely asthmatic patients, and
- **extensive sinus disease** was identified in 24% of those patients.

Of asthmatic children, 44-70% exhibit clinical, endoscopic, or radiological findings of sinusitis.[36-38] In a group of 25 adult patients with CRS who had failed to respond to medical treatment, 24% had asthma and 36% had small airway disease.[39]

In asthma, 7% of patients have nasal polyposis [40] The proportion is

- higher in patients with nonatopic (nicht erblich) asthma (13%)
- than in those with atopic (erblich) asthma (5%).[41]

Late-onset asthma is associated with development of nasal polyposis in 10-15%.[40]

In patients with **nasal polyposis**,

- approximately 30% have asthma[42] and
- 15% have aspirin-intolerance.[43]

With patients having both **asthma and nasal polyposis**

- in approximately 69%
  - asthma is the first disease to develop, and
  - nasal polyposis takes between 9 and 13 years to be diagnosed.
- in only 10% of these patients both diseases develop simultaneously, and
- in the remaining patients (21%) polyps develop first followed 2-12 years later by asthma.[44]

Patients with **asthma, nasal polyposis and aspirin sensitivity**

- are usually nonatopic (nicht erblich) and the prevalence increases in those older than 40 years.
- When parents have asthma, nasal polyposis and aspirin sensitivity, their children more commonly have nasal polyposis and rhinosinusitis than do control children.[46]
- Of 500 patients with aspirin-induced asthma, almost 80% had symptoms of rhinosinusitis such as nasal blockage and rhinorrhoea.
- Abnormalities in the paranasal sinuses were detected in 75% of these patients. The combination of air-fluid levels, mucosal thickening and opacification was a characteristic finding in the paranasal sinuses. Nasal polyposis was diagnosed in 62% of aspirin-sensitive patients.[47]

In nasal polyposis the **male:female ratio** is 2: 1.

Women with nasal polyposis, however, are

- 1.6 times more likely to be asthmatic and
- 2.7 times more likely to have allergic rhinitis than are men.[45]

GMS Curr Top Otorhinolaryngol Head Neck Surg. 2015 Dec 22;14:Doc09. doi: 10.3205/cto00124. eCollection 2015.

## Pathophysiology of chronic rhinosinusitis, pharmaceutical therapy options.

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Research in immunology has brought great progress in knowledge of inflammatory processes in the last 2 decades, which also has an impact on the upper airways. Our understanding of the pathophysiology of chronic rhinosinusitis developed from a rather mechanistic point of view with a focus on narrow clefts and mucociliary clearance to the appreciation of a complex network of immunological pathways forming the basis of disease. We today differentiate various forms of inflammation, we start to understand complex immune-regulatory networks and the reasons for their failure, and have already developed innovative approaches for therapy for the most severely ill subjects. Due to this new knowledge 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 humanized monoclonal antibodies. Several hundred of those 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

PMID: 26770283 [PubMed] PMID: PMC4702058

Free PMC Article

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## Microbiology of chronic rhinosinusitis.

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### 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
- *Streptococcus pyogenes*.

The most common isolates in chronic rhinosinusitis (CRS) are

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

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

- nosocomial sinusitis,
- the immunocompromised host,
- individuals with human immunodeficiency virus infection, and in
- 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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