

Revision Endoscopic Sinus Surgery: The St. Paul's Sinus Centre Experience

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ABSTRACT

Objective: To determine the most common findings in patients undergoing revision endoscopic sinus surgery (ESS) presenting to a tertiary rhinology centre. It is our aim that by identifying these findings, the common pitfalls in primary ESS can be avoided to prevent the necessity for revision ESS.

Methods: The findings of 73 cases of revision ESS from July 2006 to March 2007 presenting to the St. Paul's Sinus Centre were recorded and then presented.

Results: There are many common findings at revision ESS, including residual uncinate process, persistent septal deviation, nonphysiologic maxillary antrostomies, incomplete ethmoidectomy, and partial or total resection of the middle and superior turbinate, resulting in the formation of the "uniturbinate."

Conclusion: Many common findings in revision ESS can be avoided with proper primary surgery.

SOMMAIRE

Objectif: Déterminer les constatations les plus fréquemment rencontrées chez les patients subissant une reprise de chirurgie endoscopique sinusienne dans un centre de rhinologie tertiaire. Nous espérons qu'en identifiant ces pierres d'achoppement, elles pourraient être évitées lors de la chirurgie primaire éliminant le besoin d'une reprise.

Méthode: Nous avons enregistré et présenté les constatations de 73 cas de chirurgie endoscopique sinusienne de révision opérés au St-Paul Sinus Center entre juillet 2006 et mars 2007.

Résultats: Nous avons souvent trouvé les mêmes problèmes lors de nos chirurgies de révision: un processus unciforme résiduel, une déviation septale persistante, une antrostomie maxillaire non-physiologique, une ethmoïdectomie incomplète, été la résection partielle ou complète des cornets moyen et supérieur résultant en la formation d'un cornet unique.

Conclusion: Plusieurs constatations fréquentes lors des reprises de chirurgie endoscopique des sinus pourraient être évitées lors de la chirurgie primaire.

Key words: endoscopic, revision, sinus

With an increasing number of functional endoscopic sinus surgery (FESS) procedures being performed for patients with medically resistant chronic rhinosinusitis (CRS), there continue to be a significant number of surgical failures with persistent disease. Despite reported success rates of 76 to 98%,¹ a large number of patients continue to have persistent symptoms.

Of the extensive number of reasons for surgical failure, the list can be broadly grouped into systemic (nonmechanical) and anatomic (mechanical) causes. Anatomic causes can include a retained uncinate process, failed maxillary antrostomy either by excessive enlargement or postoperative stenosis, scarring of the ethmoid cavity secondary to incomplete resection or a lack of postoperative débridement, residual septal deviation, and the various changes from unnecessary turbinate resection.

The purpose of this review is to determine the most common causes of surgical failure based on operative findings at our facility and to provide a management plan for minimizing surgical failure.

Methods

After obtaining local Institutional Review Board approval, patients requiring revision FESS for persistent symptoms

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despite previous surgery and failed maximal medical management were identified and included. All patients were assessed with a complete history and rhinologic examination at the St. Paul's Sinus Centre (SPSC) and consented by the senior author (A.R.J.).

All patients underwent standard preoperative medical treatment, including antibiotics and oral corticosteroids as required. All patients underwent meticulous revision computer-assisted sinus surgery. All patients followed standard postoperative protocol at the SPSC, including nasal saline irrigation, a short (1 to 2 weeks) postoperative oral antibiotic and oral corticosteroid regimen, and meticulous endoscopic débridement at 1 and 4 weeks postoperatively.

Results

Seventy-three patients underwent revision FESS under the direction of the senior author over an 8-month period. This group included 37 male patients and 36 female patients. The average age was 51.6 (17–84) years. Fifty patients had a preoperative diagnosis of CRS and 23 patients had a preoperative diagnosis of allergic fungal sinusitis (AFS) based on the criteria established by Bent and Kuhn.² Sixty-three (86.3%) patients required bilateral revision FESS and 10 (13.7%) underwent unilateral revision FESS.

The average number of previous surgeries is listed in Figure 1. The number of overall previous surgeries is graphed, along with the number of previous surgeries by the senior author.

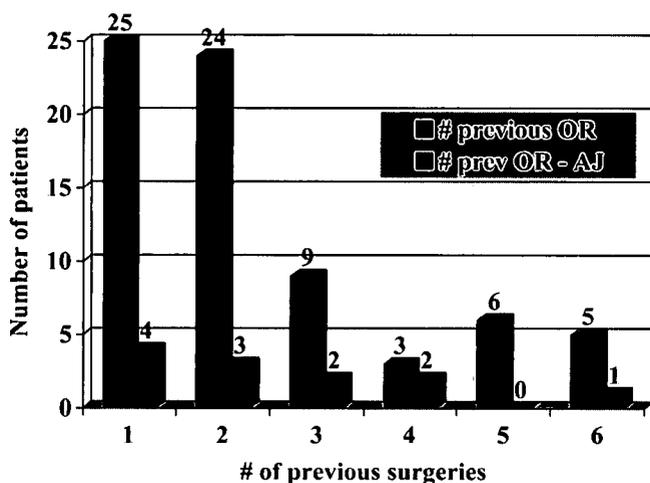


Figure 1. Number of previous surgeries (OR). AJ = senior author. (Graph does not include one patient who has previous unilateral surgery.)

Residual uncinata processes were found bilaterally in 37 patients (50.6%) and unilaterally in 6 (8.2%) patients. Residual septal deviation obstructing access to the middle meatus on the deviated side was found in 27 patients (37%). Twelve of these patients had previous inadequate septoplasty. Two patients (2.7%) had nasal septal perforations from previous septal surgery.

Ethmoid cavities were evaluated for excessive scarring and residual air cells. The results of those findings are summarized in Table 1.

Frontal recesses were assessed for scarring, residual agger nasi cells, and the presence of frontal cells. The results of excessive frontal recess scarring and residual agger nasi caps are summarized in Table 2. Type 3 frontal cells were found in two patients (2.7%). Type 1 and 2 cells were not seen. Fourteen patients (19.2%) required frontal stenting to promote healing and prevent restenosis. Five patients had bilateral stenting and 9 had unilateral stenting (19 sides). Ten of the sides (52.6%) requiring stenting had resected middle turbinates from previous surgery. Three patients (4.1%) required an "above and below" approach for recurrent frontal sinus disease and one patient (1.4%) had an obstructing frontal osteoma.

Turbinate resection, partial or complete, was evaluated in all patients. Twenty-three patients (31.5%) had bilateral partial or total middle turbinate resection and 7 patients (9.6%) had previous unilateral middle turbinate resection (53 sides in total). Six patients (20%) had middle turbinate resection with adhesion to the lateral nasal wall resulting in frontal recess obstruction (11 sides). Four patients (5.5%) had complete resection of their inferior turbinates. One patient (1.4%) had resection of all (inferior, middle, and superior) turbinates.

Maxillary sinus anastomies were assessed for excessive enlargement and scarring. The results are summarized

Table 1. Assessment of the Ethmoid Cavity

Operative Finding	Bilateral Finding, n (%)	Unilateral Finding, n (%)
Excessive scarring	55 (75.3)	6 (8.2)
Undissected cells	5 (6.8)	5 (6.8)

Table 2. Assessment of the Frontal Recess

Operative Finding	Bilateral Finding, n (%)	Unilateral Finding, n (%)
Excessive scarring	24 (32.9)	7 (9.6)
Residual agger nasu	6 (8.2)	4 (5.5)

Table 3. Assessment of the Maxillary Sinus

Operative Finding	Bilateral Finding, n (%)	Unilateral Finding, n (%)
Excessively large	35 (47.9)	4 (5.5)
Scarred outflow tract	3 (4.1)	5 (6.8)

in Table 3. Excessively enlarged antrostomies were defined as those that involved the posterior fontanelle or those that allowed visualization of the orbital floor with removal of the maxillary sinus outflow tract. Two patients (2.7%) were found to have multiple bilateral antrostomies.

Other important findings of interest in this group of revision FESS patients included 21 patients (28.8%) had a comorbid diagnosis of asthma. Two patients (2.7%) who had previous endoscopic resection of inverted papilloma with resulting sinusitis. Five patients (6.8%) had a mucocèle requiring marsupialization. One patient (1.4%) had a comorbid diagnosis of Wegener granulomatosis, and one patient (1.4%) had a comorbid diagnosis of sarcoidosis. One patient (1.4%) had a previous cerebrospinal fluid leak and one patient (1.4%) had orbital dehiscence with fat prolapse into the middle meatus. Inferior meatal windows were found in one (1.4%) patient. One (1.4%) patient had an intraoperative carotid injury owing to fracturing of osteitic bone overlying the sphenoid face. One patient had isolated sphenoid disease.

A Mann-Whitney test, two-tailed *t*-tests, and Fisher exact tests were used to compare the median number of surgeries between the CRS and AFS cohorts, as well as the number of surgeries between asthmatics and nonasthmatics. The difference in the median number of surgeries between AFS and CRS patients was not significantly different ($p = .6057$), nor were the median numbers between asthmatics and nonasthmatics ($p = .4118$).

Discussion

Seventy-three patients underwent revision FESS for persistent sinonasal symptoms despite previous surgery and maximal medical management. Forty-eight patients (65.8%) had undergone more than one sinus surgery previously, with the average number of previous surgeries being 2.36 in this cohort.

The most common anatomic finding in this population of patients was excessive scarring of the ethmoid cavity, which was present bilaterally in most patients (75.3%). A small percentage of our patient population had residual undissected ethmoid air cells bilaterally (6.8%) and

unilaterally (6.8%). This is much lower than numbers quoted by Musy and Kountakis, who found lateralized middle turbinates to be the most common anatomic finding in their group of revision patients.³ They also found a larger number of retained ethmoid air cells (64%). Sillers and Lay also quoted scarring between the middle turbinate and lateral nasal wall to be the most common finding in patients requiring revision FESS.⁴ Other common findings in patients requiring revision FESS include incomplete surgical resection of bony partitions, retained ethmoid cell walls, and remnant portions of the uncinat process or agger nasi cells and/or frontal cells.⁴ Chambers and colleagues noted that the most common cause of failure was scarring within the middle meatus, as well as residual ethmoid air cells.⁵ Chandra and colleagues reviewed the operative reports of 66 FESS cases and determined that only partial resection of the ethmoid bony lamellae and varying amounts of scar tissue were found following most primary FESS cases that required further revision.⁶ The lack of complete ethmoid sinus dissection followed by minimal or absent postoperative care can increase the risk of scar tissue formation and surgical failure.

Cohen and Kennedy stated that iatrogenic sinus disease may result from poor surgical technique, inadequate postoperative cavity débridement, and inadequate postoperative medical care.⁷ Because the goals of FESS are removal of anatomic obstruction to sinus drainage and mucosal preservation, any surgical technique that does not incorporate through-cutting forceps and directed powered instrumentation may be prone to strip excessive mucosa, with resulting bone exposure and subsequent osteoneogenesis and osteitis.⁷ The subsequent scar tissue can result in middle turbinate lateralization and maxillary sinus obstruction.⁴ There is no question that excessive ethmoid scarring contributes to middle turbinate lateralization and obstruction of the middle meatus, thereby negating the intended benefit of primary endoscopic sinus surgery.

Bugten and colleagues reported the benefits of postoperative débridement after FESS.⁸ Sillers and Lay felt that all patients should be seen 1 week postoperatively for débridement.⁴ Chiu and Vaughan also described an exhaustive postoperative débridement protocol for their patients.⁹ All patients at the SPSC undergo meticulous endoscopic débridement at 6 days postoperatively and again at 3- to 4-week intervals until the desired surgical result is obtained. The débridement of fibrin clot, retained secretions, and residual bony fragments, coupled with nasal saline irrigation, allows for optimal healing within the middle meatus. We cannot comment on the post-

operative management of surgeons who performed the initial surgery on many of the patients in this study.

The presence of residual uncinate process in our study was 50.6% bilaterally and 8.2% unilaterally. These numbers are similar to those published by Musy and Kountakis at just over 50%.³ Proper identification and removal of the uncinate process are a critical step in primary FESS as they allow for adequate visualization of the maxillary sinus ostia and can guide dissection into the frontal recess. A residual uncinate process can lead to inadequate drainage and scarring within the frontal recess and over the maxillary sinus outflow tract.

Orlandi and Kennedy felt that the two most common causes of frontal recess obstruction in the nonoperated patient are obstruction from a medially displaced uncinate process and obstruction from an enlarged agger nasi cell.¹⁰ Chiu and Vaughn found that patients with frontal recess obstruction after primary surgery often have remnant agger nasi and frontal cells, as well as scar tissue and/or osteoneogenesis, causing the obstruction.⁹ In addition, frontal recess and supraorbital ethmoid cells, often unrecognized in primary surgery, may contribute to frontal recess narrowing; 32.9% of our patients had excessive scarring in the frontal recess bilaterally and 8.2% had retained agger nasi caps bilaterally. A common cause of failure of frontal sinus surgery is mistaken identity of the frontal recess, supraorbital, and agger nasi cells when viewed endoscopically from below.¹¹ Knowledge of the three-dimensional endoscopic anatomy in this region is therefore critical for a successful outcome. Chandra and colleagues stated that the causes of failure after FESS commonly included residual bony lamellae and scar tissue formation.⁶ They noted frontal ostial stenosis in up to 25% of revision cases. This is common when the ethmoid cavity has been incompletely dissected. Bradley and Kountakis also stated the importance of identifying the agger nasi cap and properly addressing it at primary surgery.¹² Proper frontal sinus surgery requires advanced surgical techniques, including the use of angled endoscopes, specialized frontal sinus instrumentation, and the ability to perform advanced frontal sinus procedures as necessary.¹³ These techniques, coupled with detailed anatomic knowledge of the frontal recess, are essential for successful frontal sinus surgery.

Complete or partial resection of the middle turbinate and its consequent lateralization is a common cause of primary surgical failure. With the exception of tumour involvement of the turbinate or a prominent concha bullosa, where resection of the lateral half of the middle turbinate is required to relieve obstruction of the osteomeatal complex, there are few pathologic conditions

that require partial or complete resection of the middle turbinate.³ We do not feel that paradoxical curvature of the middle turbinate is an adequate indication of middle turbinate resection. In our population of patients, two patients had resection of their middle turbinates for the treatment of inverting papilloma. The remainder of the patients had no surgical indication for turbinate resection. In 14 patients requiring stenting of the frontal recess to promote healing and prevent stenosis, 10 sides (52.6%) had evidence of middle turbinate resection. Sillers and Lay pointed out that when there has been either partial or complete resection of the middle turbinate, orientation for the revision surgeon is significantly altered and can lead to avoidable injury of the ethmoid roof and medial orbital wall.³ The formation of a "uniturbinate,"^{7,14} a single stunted turbinate at the skull base formed from the fusion of the remnant middle and superior turbinates, is a common finding following partial resection of the middle turbinate. This can lead to loss of important landmarks for the revision sinus surgeon. Resection of turbinates can also lead to increased crusting, dryness, atrophic rhinitis, and, in an extreme situation, "empty nose syndrome."¹⁵ As noted by Van Alyea in 1951 and again by Kennedy in 1998,^{16,17} we should strive toward conservation of a functional and physiologic structure whenever possible.

Performing a proper maxillary antrostomy is a crucial step in primary FESS. Unfortunately, it is often inadequately performed, resulting in a chronically diseased maxillary sinus from recirculation and/or scar separation from the nasal cavity.⁷ The recirculation phenomenon, or "missed ostium sequence," as described by Parsons and colleagues,¹⁸ is caused by a retained or partially resected uncinate process coupled with the formation of an iatrogenically created posterior ostium. Mucus then flows out of the natural maxillary sinus ostia and back into the maxillary sinus via the posteriorly created ostium. This results in functional obstruction of maxillary sinus drainage. We do not recommend enlarging the maxillary sinus ostia posteroinferiorly as it can result in a reduction in nitric oxide concentration, dryness of the sinus mucous membranes, and loss of normal mucociliary clearance patterns at the natural outflow track. Angled endoscopes may be necessary for adequate visualization of the natural maxillary sinus ostium⁷ and should be used routinely to carry out uncinectomies and to identify the natural ostia.

Image guidance is used routinely at the SPSC for all revision cases. Several other authors reported on the importance of using image guidance for revision surgery.^{4,9} We strongly support the American Academy of Otolaryngology-Head and Neck Surgery guidelines recom-

mending the routine use of stereotactic navigation for all cases of revision sinus surgery.

A comorbid diagnosis of asthma was present in 28.8% of this patient population, similar to what was reported by Musy and Kountakis.³ Patients with underlying systemic illnesses, including cystic fibrosis, primary ciliary dyskinesia, Samter triad, immunodeficiencies, and gastroesophageal reflux disease, may fail despite adequate initial surgery.³ Increased failure rates after FESS have been associated with various systemic illnesses, whereas other authors failed to report a difference in outcomes in asthmatic patients.¹⁹⁻²³ Our study found that the number of revision surgeries in patients with asthma compared with those without asthma is not significantly different. As well, there is no increase in the number of revision surgeries when comparing AFS with CRS. Our purpose was to determine the anatomic causes of failure, and those patients with other systemic comorbidities requiring revision will continue to be followed prospectively.

It is important to end this discussion by stating that not all revision cases are necessarily a result of anatomic failure; some failures are secondary to the underlying systemic or local medical condition and may require repeated intraoperative débridement at varying intervals. In the current study, 21 patients had a diagnosis of AFS and 21 patients had asthma listed as a comorbidity. It is well known that these groups of patients will have a higher rate of revision surgery. One patient had a concurrent diagnosis of Wegener granulomatosis and one patient had sarcoidosis as a comorbidity.

Conclusion

The principles of primary FESS, including the removal of anatomic obstruction to mucous flow and the preservation of mucosa, are also essential to successful surgical management in revision FESS. Adequate pre- and postoperative management further improve the chances of a successful outcome in revision FESS. Avoidance of mucosal stripping, meticulous and gentle handling of tissues, and preservation of the middle turbinate are general principles that should be followed to avoid failure in FESS. A detailed knowledge of the three-dimensional endoscopic anatomy and meticulous surgical technique are also essential prerequisites to successful primary and revision FESS.

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