

# The Clinical Applications of Image Guidance in Revision Endoscopic Frontal Sinus Surgery



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## Abstract

**Background:** Frontal sinus disease is obstinate. With its multifaceted anatomy and neighboring vital structures, frontal sinus disease creates a dreaded encounter to every otolaryngologist. Further complicated are revision endoscopic frontal sinus surgeries beside unrecognizable anatomy, revision endoscopic frontal sinus surgeries present technical challenges. The objective is to highlight the causes of revision endoscopic frontal sinus surgery and illustrate the clinical applications of the image guidance in managing them.

**Methods:** Retrospective review of 60 patients underwent revision endoscopic sinus surgery with image guidance from 2015 to 2019

**Results:** the causes of revision out of 60 patients 33% were due to retained uncinat process, residual agger nasi with/without ethmoid disease. Followed by 25% due to extensive mucosal disease with polyps then 24%, 11% and 5% presenting lateralized middle turbinate, unopened suprabullar cell and neo-osteogenesis, respectively. All patients were followed up for 3 years with 91.67% successful patency rate of frontal outflow after revision.

**Conclusion:** the image guidance in revision endoscopic frontal sinus surgery provides accurate identification of remnant bones or cells that may obscure the outflow. Its further aids in evading recurrence or persistent disease with adequate frontal sinusotomy while protecting vital structures.

**Keywords:** Frontal sinus; Revision endoscopic sinus surgery; Image guided endoscopic sinus surgery

## Introduction

Frontal sinus surgeries throughout the history have been tiresome. Even in the hands of experts frontal sinus surgeries outcomes have been debatable. The available success rate of primary functional endoscopic sinus surgeries varies from 76-98% [1]. None the less almost 25% of operated individuals eventually require revision surgery for unrelenting or recurrent symptoms. Published data by Khalil et al. [2] displayed causes of failure including residual frontal air cells, posterior or anterior ethmoid air cells, residual uncinat process, deviated nasal septum or middle turbinate lateralization [3]. Many of which would contribute to frontal recess blockage where the disease is most probably to reoccur [4]. The purpose of this study is to emphasize the causes of failed primary endoscopic frontal sinus surgeries and illustrate the clinical applications of the image guidance in managing them.

## Aim

To study the clinical applications of image guidance in managing the different causes of revision endoscopic frontal sinus

surgeries.

## Methods and Materials

Retrospective charts review of 60 patients underwent revision endoscopic frontal sinus surgery with image guidance for chronic recurrent sinusitis with and without polyposis from 2010 to 2019 at a tertiary referral hospital of King Fahad Specialist Hospital Dammam , the eastern province of Saudi Arabia with 4 million population.

## Results

The causes of revision surgery and frontal disease reoccurrence (Table 1) showed variable causes. From the 60 patients reviewed 33% were due to retained uncinat process, residual agger nasi with/without ethmoid disease. Followed by 25% due to extensive mucosal disease with polyps then 24%, 11% and 5% presenting lateralized middle turbinate, unopened suprabullar cell and neo-osteogenesis, respectively (Table 1).

All patients were followed up for the period from 1 to 5 years with 91.67% successful patency rate of frontal outflow after image

guided endoscopic revision. Few Illustrative cases demonstrating the value of image guidance in managing different causes of revision endoscopic frontal sinus surgery (Figures 1-9).

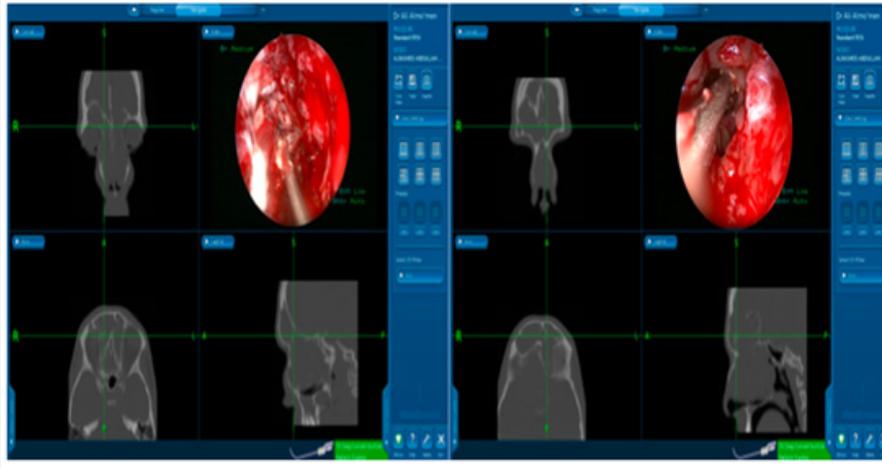


Figure 1: Avoidance of orbital and intracranial injuries.



Figure 2: Accurate location of the probe touching the posterior right frontal sinus wall.

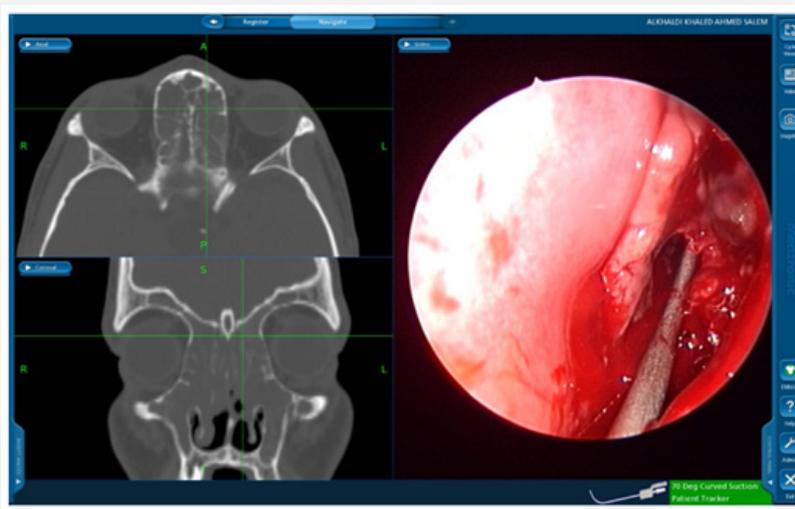


Figure 3: Incomplete dissection of uncinate process.



Figure 4: Infected undissected frontal cell.

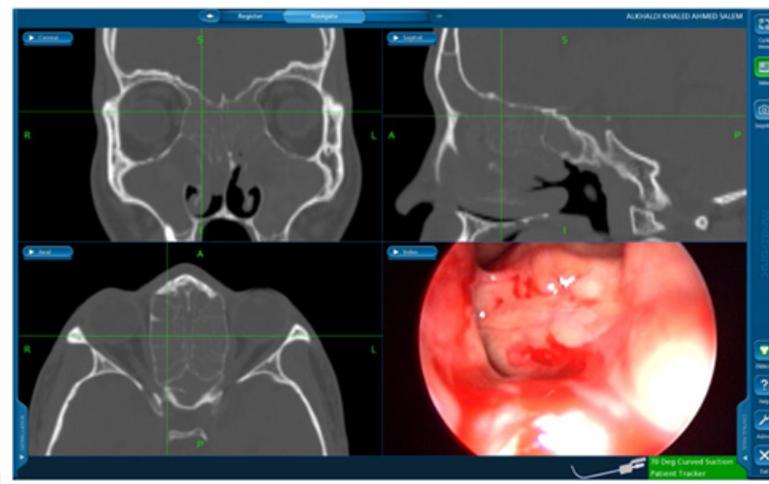


Figure 5: Suprabullar cell dissection.



Figure 6: Edematous lateralized middle turbinate.

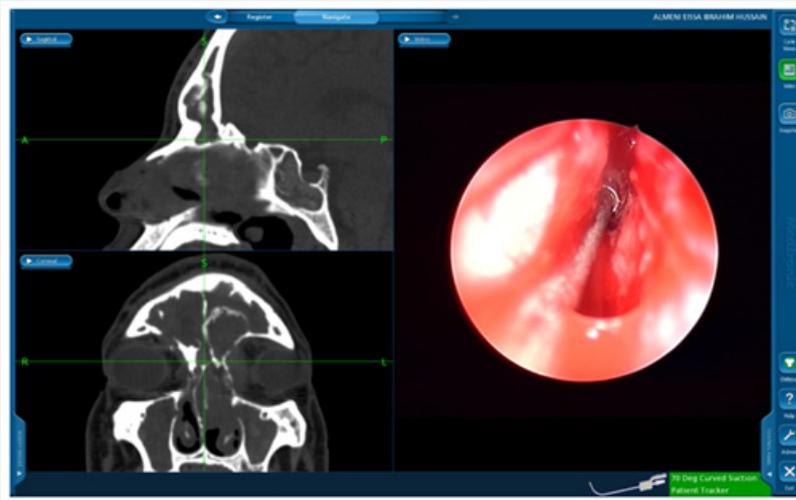


Figure 7:Neoosteogenesis obstructing the frontal sinus flow.



Figure 8: Polyps obstructing frontal sinus flow.

Table 1: The pathological and anatomical causes of revision identified by pre-operative CT scan and intra operative surgical dissection summarized.

	Etiology	No. of Cases
1	Retained uncinata process, residual agger nasi with/ without ethmoid disease	20 (33%)
2	Extensive mucosal disease with polyps obstructing the frontal recess	15 (25%)
3a	Lateralized middle turbinate with/without frontal recess scarring	8 (13%)
3b	Lateralized middle turbinate with residual uncinata process or agger nasi cell	7 (11%)
4	Unopened suprabullar cell with/without frontal cells	7 (11%)
5	Neo-osteogenesis complete frontal recess bony obstruction	3 (5%)
	Total	60

### Discussion

Frontal sinus surgeries present a challenge due to its unique outflow anatomy. Resting between vital structures as the orbit

and base of skull attaining an adequate outflow whilst avoiding complications is a trial. The complexity of frontal recess air cells presents another obstacle in the goal of achieving flow. Whilst taking in consideration these difficulties in a primary case frontal

sinusitis in a revision case magnifies the challenge. Interpreting the cause of recurrence needs thorough evaluation of the patient's radiological and clinical evaluation. A CT scan should be performed in all patients after 4-6 weeks of medical treatment trial and avoidance of imaging during an acute upper respiratory tract infection is also advisable [4].

Since its development in the 1980s in Germany image guidance immersed a new platform for otolaryngologist. Contiguous 1mm thickness CT scan slices with 3-D reconstruction aids in diagnosing and providing accurate localization of bony partitions and boundaries [5,6]. In a study conducted by Loehrl et al. 31 patients underwent revision endoscopic frontal sinus surgery with image guidance with an average 11.9 months follow up. The authors commended that integrated instruments make revision frontal sinus surgeries efficient by utilizing the instrument after immediate localization has been accomplished [7].

Such accuracy is demonstrated in the illustrated cases in Figure 1 & 2 where in Figure 1 the navigation aided in surgeon's advancement in the narrow areas between the orbit and skull base easing the technical challenge. And Figure 2 shows precise localization of the integrated probe touching the frontal sinus posterior wall. The benefit of image guidance can help in the diagnosis of the causes of frontal outflow blockage. In literature recurrent frontal disease can have variable causes highest being incomplete removal of uncinata process or air cells, iatrogenic injury or recurrent mucosal edema or frontal ostium stenosis [8].

Where is Valdes et al reported the findings in recurrent frontal disease in 66 patients to be 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%) [9].

In the 60 patients reviewed the most common cases of frontal sinostomy failure were due to retained uncinata process, residual agger nasi with/without ethmoid disease (33%). Figure 3 & 4 display cases of retained uncinata process and undissected frontal air cell, respectively. Bradely et al. [10] recognized agger nassi cell in 93% of CT scan slides of their revision functional endoscopic sinus patients [10]. Whereas Nakayama et al also concluded through CT scan slide revision that residual frontal recess cells were independent risk factors for postoperative frontal sinusitis [11].

Suprabullar cells are also a recognizable cause of recurrence where is can be wronged for base of skull during primary surgery and left untouched [12]. That represents 11% of the findings in the revision cases in this study such as the illustrated case in Figure 5. In another recognizable cause 24% of the revised patients had lateralization of the middle turbinate Figure 6. This lateralization was found to be due to scarring between the turbinate and retained

air cells or uncinata process 13%, 11% respectively. Other causes include neo-osteogenesis, which believed to be caused by failure to preserve normal mucosa [13]. Neo-osteogenesis as seen in Figure 7 presented 5% of our findings.

Even recurrence of the mucosal disease itself that is seen in Figure 8 presented as a cause of recurrence in 25% of our revised cases. Although higher rates have been reported in literature where Valdes et al. [9] reported a rate as high as 92.7% of edematous or hypertrophic mucosa found in CT scan of revised cases.

## Conclusion

In conclusion, frontal sinus outflow presents a challenging technical surgery for all otolaryngologists. That difficulty is magnified in revision cases where anatomy is distorted and recognition of causes of failure is demanding. Image guidance is prized instrument in performing such cases. Thorough dissection of all remnant bony partitions in the frontal recess is achievable with the assistance of image guidance. Achieving maximum drainage with preservation of vital structures is easily attained with accurate localization provided with image guidance.

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