**The Unzip Technique for Removal of Large Supra Agger Frontal Cells (SAFC or Formerly Kuhn Type 3) during Endoscopic Frontal Sinusotomy**

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# Abstract

## Objectives: To evaluate performing endoscopic frontal sinusotomies in the setting of large supra agger frontal cells (SAFC or formerly known as Kuhn type 3 frontal cells) using the unzip technique during endoscopic sinus surgery. Methods: A review of prospectively collected data was performed of 32 consecutive patients (37 sides) who underwent endoscopic frontal sinusotomies for SAFCs between January 2012 and October 2016 to identify and evaluate subjects the unzip technique for removal of SAFCs was performed. Data collected and analyzed included demographics, CT imaging characteristics, findings at surgery, use of frontal sinus stents, preoperative and postoperative SNOT-22 quality of life scores, primary versus revision surgery, and size of intraoperative and postoperative frontal sinusotomy, and complications. The operative technique was described. Results: Eighteen (18) subjects (23 sides) underwent successful frontal sinusotomies and removal of SAFCs using the unzip technique. All sides had endoscopically confirmed persistent postoperative patency with a mean follow-up of \_\_.\_ months. None of the patients required revision surgery. No cases of CSF leak, epistaxis requiring packing or cauterization, or orbital injury occurred. Conclusion: The unzip frontal sinusotomy technique for removal of Kuhn type 3 frontal cells provides safe and effective access to the native frontal sinus when the natural outflow tract can be identified. Key Words: Anatomy, frontal sinusitis, sinus surgery, endoscopic, frontal cell.

# Introduction

## Surgery of the frontal sinuses remains one of the most difficult aspects of endoscopic sinus surgery (ESS).1 The complex anatomy and high variability of the frontal outflow tract result in higher rates of stenosis in frontal sinus surgery than surgery in the other paranasal sinuses. The Bent and Kuhn classification of frontoethmoidal cells is one of the most widely cited.2 One particularly large frontal cell in the classication, the type 3 frontal cell, is described as a large cell above the agger nasi cell that invaginates into the frontal sinus cavity. A recent consensus review introduced The International Frontal Sinus Anatomy Classification in which the Kuhn-type type 3 frontal cells were renamed large supra agger frontal cells (SAFC) to provide more descriptive terminology.3 These classification systems are summarized in Table 1. Large SAFCs are particularly difficult to manage endoscopically because the frontal outflow tract narrows significantly at the level of the frontal cell and tends to be located posteromedially adjacent to the lateral lamella of the cribriform plate.3,4 Surgery in this area thus may have higher risk of skull base injury and cerebrospinal fluid leak. Draf described extents of endoscopic frontal sinus surgery techniques. Draf I is the most conservative procedure of the frontal sinus and includes removal of the posterior wall of the agger nasi cell. Draf IIa frontal sinusotomy is the opening of the frontal sinus outflow tract from the medial orbital wall to the middle turbinate, including removal of frontal cells or supraorbital ethmoid cells. Draf IIb frontal sinusotomy is an extended procedure with the removal of the frontal sinus floor and excision of part of the middle turbinate. Draf III frontal sinusotomy (also called modified Lothrop procedure) includes connecting the frontal sinuses with anterosuperior septectomy and removal of the intersinus septum.5 Despite this classification, few surgical techniques have been published that specifically address approaches to large SAFCs during endoscopic frontal sinusotomy. Wormald described an axillary flap approach to the frontal recess that also mentions addressing SAFCs from an anterior approach and fracturing the cell with a curved curette; however, the author does not provide a detailed description of the technique in this article.6 A centrifugal frontal sinus technique has been described in which a curved image-guidance probe was used to puncture through the roof of the frontal sinus cell before further performing the sinusotomy from this initial site. This technique avoids the natural outflow tract and relies on image guidance accuracy.7   This study assesses a technique to safely and effectively performing endoscopic frontal sinusotomy through the natural outflow tract in the setting of obstructive SAFCs.

# Technique

Consecutive subjects who had computed tomographic evidence of frontal sinusitis with obstructive unilateral or bilateral large SAFCs and underwent endoscopic sinus surgery between January 2012 and October 2016 were evaluated for inclusion in the study. As the study technique requires excising the frontal cell via the natural frontal outflow tract, subjects were excluded from this study if the natural frontal sinus outflow tract could not be endoscopically or radiographically visualized. Other techniques were used for cases in which this technique could not be performed. All surgeries were performed by the author. Institutional Review Board (IRB) approval was granted by the University of Louisville School of Medicine.   
   
The surgeon first performs a thorough CT imaging interpretation of the frontal outflow tract and relationships to the skull base and orbit using three planes (coronal, axial, sagittal) to project a three-dimensional spatial reconstruction of the expected endoscopic anatomy. Maintaining hemostasis is essential to performing this technique. The author performs an endoscopic sphenopalatine artery block using 1% lidocaine with 1:100,000 epinephrine. Because of its balanced relative effectiveness-to-safety profile, the author uses topical pledgets with 1:1000 epinephrine for decongestion and hemostasis at the preparatory phase and during the surgery.8 While this decongestant is safe when used topically,9 it is important to note that accidental injection of 1:1000 epinephrine can be fatal; therefore, the author tents the solution with small drop of methylene blue to distinguish it from the injectables and makes sure all containers are properly labeled before proceeding with the case. Complete uncinectomy, maxillary antrostomy, and total ethmoidectomy are performed or revised under endoscopic guidance prior to approaching the frontal outflow tract. A skull base dissection using thru-cutting instruments is performed from posterior to anterior by removing partitions to the skull base and opening any ethmoid cells along the skull base. Because the natural outflow tract in the presence of a Kuhn type 3 frontal cell can commonly be located in a fairly posterior and medial position, it is recommended that both anterior and posterior ethmoidectomies are performed. The agger nasi cell is opened and removed using angled instrumentation. At this point, the cavity of the Kuhn type 3 frontal cell is visualized. Importantly, this cavity can mimic a patent frontal sinusotomy as large large SAFCs often extend deep into the frontal sinus cavity. Some endoscopic visual cues to distinguish a frontal cell cavity from a true frontal sinus cavity include: 1. The posterior wall of a frontal cell tends to project more vertically than the posterior frontal sinus skull base, which tends to slope in a more posterior plane. 2. A partition just medial to the middle turbinate with a narrow tract in between may be seen with an unremoved Kuhn type 3 frontal cell and is not present with a patent frontal sinusotomy. 3. A stereotactic guidance probe has a hardstop before the top of the frontal sinus cavity on imaging despite the tip of the probe appearing to be well within the frontal sinus cavity. The roof of a Kuhn type 3 frontal cell typically does not extend to the top of the frontal sinus. Likewise, placing the stereotactic guidance probe to the posterior extent of a type 3 frontal cell does correspond to the skull base on imaging.  
   
Using an angled endoscope for visualization (the author typically uses a 45-degree or 70-degree depending on the acuity of the frontal outflow tract), a plane between the middle turbinate and the medial wall of the Kuhn type 3 frontal cell is identified. Often, the remnant superior medial edge of the ethmoid bulla is encountered first as it attaches to the inferior edge of the frontal cell. A side-to-side giraffe frontal sinus thru-cutting forcep is used to “unzip” this partition superiorly by making sequential cuts of mucosa-bone-mucosa toward the natural frontal outflow tract. The author uses side-to-side frontal sinus forceps that has one nonmoving tine that follows adjacent to the middle turbinate and cribriform plate and an moving tine that opens laterally to avoid injury to the skull base. For instance, a right-opening side-to-side frontal sinus forcep is used for the left sinus cavity. Care is taken to avoid inadvertent tears of the middle turbinate mucosal lining as this tends to cause excess bleeding. The frontal outflow tract typically funnels to its narrowest point as the cribriform plate is approached. A confluence of attachments, including the superomedial wall of the ethmoid bulla, inferomedial wall of the Kuhn type 3 frontal cell, and the medial wall of the agger nasi cell, often converge at this site. The narrowest point this frontal outflow tract in the setting of a Kuhn type 3 frontal cell is typically between one to two millimeters in diameter, and its medial edge is the lateral lamella of the cribriform plate. It should be noted that this site can be in a more posterior position than a frontal outflow tract in the absence of a Kuhn type 3 frontal cell. The non-moving tine of the frontal sinus forceps is gently inserted into the frontal outflow tract, and a few cuts are performed with the forceps angled somewhat laterally. These cuts allow access into the true frontal sinus cavity. Once the opening is widened, other thru-cutting instrumentation, including an angled frontal sinus mushroom punch, Hosemann forceps, and Cobra forceps, can be used to make further cuts of the medial, posterior, and superior walls of the frontal cell with direct visualization of the skull base. Typically, the entire frontal cell can be excised to the lamina papyracea and frontal beak in a mucosally sparing technique. The roof of the frontal cell can occasionally be so high that it is difficult for even angled frontal sinus forceps to reach. As long as a widened frontal sinusotomy is created, inability to reach the superolateral edge of the frontal cell does not necessarily result in failure.

# Results

The study included \_\_ subjects and \_\_ sides. Of the \_\_ consecutive subjects undergoing frontal sinusotomy with excision of Kuhn type 3 frontal cell, \_\_ (\_\_%) were able to undergo the Unzip technique. A steroid-eluting implant (Propel, IntersectENT, Menlo Park, CA) was used if frontal sinusotomy appear to be narrow or severely inflamed. No patients required postoperative sinonasal packing or or cauterization for excessive postoperative epistaxis. No orbital or skull base (cerebrospinal fluid leak) injuries occurred. Patency of the frontal sinusotomy was maintained in \_\_ (\_\_%) of sinus cavities with a mean follow-up of \_\_ (SE +/- \_\_). The mean frontal sinusotomy measured \_\_ mm (SE +/- \_\_) anteroposteriorly by \_\_ mm (SE +/- \_\_) mediolaterally at the time of surgery and \_\_ mm (SE +/- \_\_) anteroposteriorly by \_\_ mm (SE +/- \_\_) mediolaterally at 3 months in \_\_ patients who maintained follow-up.

# Discussion

Endoscopic sinus surgery is a safe, effective surgical intervention for chronic rhinosinusitis refractory to maximal medical therapy. The frontal sinus is one of the most difficult areas operate because of the anatomic variability of frontal sinus, the requirement to use angle instrumentation and endoscopes, and the close proximity of the skull base and orbit. SAFCs (or Kuhn Type 3 frontal cells) further increase the complexity of endoscopic frontal sinusotomies as they typically impinge upon the frontal outflow tract in a posteromedial position near the lateral lamella of the cribriform plate, requiring the surgeon to perform dissection close to the skull base.3 The Unzip technique is a systematic approach through the natural frontal outflow tract that safely removes SAFCs to allow maximal opening of the frontal sinus.

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