

TITLE: Frontal Sinus Surgery

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Introduction

Chronic frontal sinusitis continues to be a difficult problem to manage surgically. This is evidenced by the multiple surgical techniques that have been advocated in the treatment of this disease. Surgical treatment options have ranged from conservative long-term medical management after surgical treatment of ethmoid sinuses to external frontal sinusotomy, osteoplastic fat obliteration, the more recent endoscopic frontal sinus Lothrop procedure, and multiple variations of the above. (1) Because of the lack of prospective trials in the literature and the difficulty with double blinded trials, a true scientific answer to the best management of sinus disease is difficult. As such most sinus surgeons rely on expert opinion and experience to guide their management of these difficult patients. As such, the following is a review of the current management of frontal sinus disease as described by various experts in the field. This compilation of "How I do it's" is intended to give the reader a broad spectrum of surgical options in the management of patients with sinusitis refractory to medical treatment. With the lack of scientific evidence in the field, it is up to the physician to determine which procedure is most likely to benefit the patient in each situation.

Anatomy

Surgery of the frontal sinus requires exquisite knowledge of the anatomy of the frontal sinus, the frontal sinus drainage pathway, and the surrounding structures such as the orbit, the brain, and the other paranasal sinuses. The reader is referred to the PowerPoint presentation on this website for a pictorial review of the pertinent anatomy.

Development of the frontal sinus is initiated in the fourth fetal month when the entire nasofrontal area is represented by the frontal recess. It is the last paranasal sinus to develop. At birth, the sinus has little clinical relevance and is often indistinguishable from the anterior ethmoid cells. At 3 years of age, the frontal sinus invaginates into the frontal bone and continues its vertical growth trajectory at an average annual rate of 1.5 mm until the 15th year. Final growth is completed before 20.

The frontal sinus is on average 28mm by 27mm by 17mm and is pyramidal shaped. The sinus is compartmentalized by the intrasinus septa which divides the sinus into halves. The frontal sinus has the most complex and variable drainage of any paranasal sinus. Each frontal sinus narrows down to an inferior margin designated the frontal ostium. The frontal ostium extends between the anterior and posterior walls of the frontal sinus, is demarcated by a variably shaped ridge of bone on the anterior wall of the sinus, and is oriented nearly perpendicular to the posterior wall of the sinus. (2)

The previously termed nasofrontal duct is more appropriately called the frontal sinus drainage pathway as it is not a true duct. It has superior and inferior compartments. The superior compartment is formed by the union of adjacent air spaces at the anteroinferior portion of the frontal bone and the anterosuperior portion of the ethmoid bone. Its upper border is the frontal ostium. It communicates directly with the inferior compartment. The inferior compartment of the frontal sinus drainage pathway is a narrow passageway formed by either the ethmoid infundibulum or the middle meatus. When the anterior portion of the uncinate process extends superiorly to attach to the skull base, the inferior compartment is the ethmoid infundibulum. This then communicates with the middle meatus via the hiatus semilunaris. When the anterior portion of the uncinate process attaches to the lamina papyracea instead of the skull base, the inferior compartment is the middle meatus itself.

The term agger nasi refers to the mound of bone anterior to the insertion of the middle turbinate. Agger nasi cells, when markedly pneumatized can cause obstruction of the frontal sinus drainage pathway and thus have surgical implications. A second group of frontal recess cells are termed the frontal cells. They are superior to the agger nasi cells and can show variable pneumatization. Bent and Kuhn offered a description of these cells into 4 patterns: Type 1 being a single cell above the agger nasi; type 2, a tier of two or more cells above the agger cell; type 3, a single cell extending from the agger cell into the frontal sinus; and type 4, an isolated cell within the frontal sinus. (3) Finally, cells originating posterior to the frontal sinus and pneumatizing superior to the orbit are termed supraorbital ethmoid cells.

Further classifications have been established to characterize the attachment site of the uncinate process. Types 1-6 have been described, with types 1-2 attaching to the lamina papyracea, types 3-5 attaching to the skull base, and type 6 attaching to the middle turbinate. Attention has been focused on the attachment of the uncinate process as it determines the location of the frontal sinus. If the uncinate attaches to the lamina papyracea, the infundibulum will end in a blind ending pouch termed the terminal recess. The frontal sinus will then drain directly into the middle meatus. If the uncinate attaches to the skull base or the middle turbinate, the frontal sinus will drain into the infundibulum prior to entering the middle meatus. Multiple studies have been done to characterize the drainage of the frontal sinus. The consistency of the studies is that all conclude that the anatomy in the frontal recess is variable.

Indications

Surgical options for the frontal sinus have grown with the advent of endoscopic sinus surgery. Listed below is a brief description of the surgical options most popular today. Indications for frontal sinus surgery are for the treatment of the following medical conditions: chronic sinusitis unresolved with maximal medical therapy; polyps of the sinus; allergic fungal

sinusitis causing symptoms; periorbital and intracranial complications of sinusitis; marsupialization of mucocoeles or mucopyocoeles; resection of benign neoplasms such as osteomas, inverting papillomas, or fibrous dysplasia. Surgeons should approach surgery to the frontal sinus with caution. Unlike surgery in the sphenoid where immediate complications are the main concern, surgery in the frontal sinus most often results in delayed complications. Stenosis of the frontal sinus drainage pathway can result from circumferential trauma to the recess and cause chronic frontal sinusitis and intracranial complications. Revision surgery in these cases is mandatory to restore natural frontal sinus drainage. As such, initial surgery to control disease of the frontal sinus usually involves a complete uncinectomy and anterior ethmoidectomy to allow downstream control of frontal sinus obstruction.

Surgical Options

Dr. Wolfgang Draf popularized three endoscopic procedures to the frontal sinus termed Draf types I, II and III. The endoscopic frontal recess approach (Draf type I) procedure is indicated when frontal sinus disease persists despite more conservative endoscopic approaches directed at the infundibulum and anterior ethmoid region. This procedure involves complete removal of the anterior ethmoid cells and uncinete process surrounding the frontal recess to the frontal ostium. Obstructing frontal cells, if present, are removed. The frontal sinus ostium may then drain into a patent frontal recess. The endoscopic frontal sinusotomy, or Draf II procedure, is indicated for patients with severe forms of chronic frontal sinus disease that have failed after endoscopic frontal recess approach. This extended drainage procedure involves resection of the floor of the frontal sinus from the nasal septum medially, to the lamina papyracea laterally. The dissection involves removal of the anterior face of the frontal recess. Thus, the frontal sinus ostium is enlarged to its maximum dimension. This procedure can be very difficult to distinguish from the endoscopic frontal recess approach (Draf I) on coronal postoperative imaging. Evaluation of multiple consecutive coronal images or sagittal reformatted images can demonstrate extensive removal of the anterior face of the frontal recess and frontal sinus floor when compared to the frontal recess approach. The endoscopic frontal sinusotomy (Draf II) procedure can be easily distinguished from the Draf III procedure by the lack of resection of the superior nasal septum and entire frontal sinus floor. The modified Lothrop procedure, or Draf III procedure, may also be referred to as median drainage. This procedure, in its present form, was first described in the mid-1990s and has been gaining popularity among rhinologists. Indications include the most severe forms of chronic frontal sinusitis where osteoplastic flap with obliteration is the only alternative. This procedure involves removal of the inferior portion of the interfrontal septum, the superior part of the nasal septum, and the frontal sinus floor to the orbit laterally. The lamina papyracea and posterior walls of the frontal sinus remain intact. Authors in Japan compared long term results with the Draf II and III procedures and concluded that the Draf III allows for better long term patency of the frontal sinus.

In addition to endoscopic approaches to the frontal sinus, several external approaches are available to the otolaryngologist. Among those, the simplest is a frontal sinus trephination. Frontal sinus trephination involves making an opening in the inferior wall of the frontal sinus through an incision along the inferior aspect of the medial eyebrow. The inferior wall of the frontal sinus is devoid of bone marrow which may lessen the risk of developing osteomyelitis. The sinus can be entered with a sharp trocar or drill. For particularly small frontal sinuses or to gain access to isolated type 4 frontal sinus disease, image guidance can be used to guide the

surgeon to the correct entrance sight. The procedure is indicated in cases of complicated acute frontal sinusitis to allow release of pus and irrigation of the sinus to prevent impending intracranial complications. Additionally, it can be used in conjunction with endoscopic approaches to the frontal sinus in chronic frontal sinusitis or frontal sinus mucocoeles, when the trephination is used to positively identify the frontal duct and pass a catheter through it into the nasal passage to stent it and prevent its stenosis. The main advantage to this approach is that it provides fast and easy access to the frontal sinus and allows placement of a drain for irrigation of the sinus. The main disadvantages are its associated scarring, risk of sinocutaneous fistula formation, and the risk of injury to the supraorbital nerve bundle and the trochlea that can cause diplopia. (5)

Another external approach is the osteoplastic flap with or without obliteration. This approach is indicated for malignant and benign lesions of the frontal sinus that cannot be reached endoscopically, for previously failed endoscopic approaches to the frontal recess, or for situations where injury to the frontal sinus drainage pathway are not likely to be repaired. The sinus is approached through a brow, midforehead, or bicoronal incision. Care is taken to avoid injury to the supraorbital and supratrochlear neurovascular bundles. The entrance to the sinus can be determined by using a template made from a 6 foot Caldwell x-ray which approaches the exact size of the frontal sinus. Other methods include the use of image guidance and use of a wire thorough a trephination sight to palpate the extent of the sinus. Cuts should be beveled through the bone to prevent collapse of the anterior table into the sinus postoperatively. If obliteration is necessary, a drill should be used to assure that all mucosa has been removed from the sinus. The sinus can be obliterated with fat, bone marrow, pericranial flaps, or synthetic materials. Most authors today prefer endoscopic approaches to open the frontal recess widely. The endoscopic approaches can be combined with external approaches to handle most disease processes. This approach aids the surgeon with postoperative surveillance with CT scan.

Conclusion

Surgery of the frontal sinus is an effective form of treatment of tumors and chronic sinusitis. An expert anatomical knowledge of the area is a prerequisite to operations in the area. Surgery to the frontal recess should be approached with caution as stenosis can cause long term sequela. The Otolaryngologist should be well versed in different approaches to the frontal sinus and should be willing to use combinations to achieve the best results for their patients.

References

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