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MINIMALLY INVASIVE SINUS SURGERY

The Rationale and the Technique

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THE RATIONALE

The sinus ostia of the paranasal sinuses in children are quite small. Even *adult* cadaver studies report measurements in millimeters for most paranasal sinus ostia. The actual passageway from the sinus to the ostium may also be complicated and tortuous, as in maxillary sinus drainage.[7] When one considers the variety of etiologic factors that have the potential to cause sinonasal edema and adversely affect sinus drainage through such a small hole, it is not surprising that sinus disease is commonplace. What *is* surprising is that, if such small sinus ostia are a predisposing factor, sinus disease is not epidemic.

Clinical observations made by the author at surgery suggest that the size requirement for the ostia to maintain a functional sinus is small to very small. Extremely small openings have been observed at surgery without any evidence of compromise in sinus health clinically or on computed tomography (CT). Further, the same small openings may show varying degrees of partial obstruction, such as polyposis, with little or no evidence of sinus disease. It is not unusual for the ostium to be visually obscured from the surgeon whether or not there is secondary sinus infection. It appears that, although sinus health is directly related to a functional sinus ostium, the size requirement for the opening is quite limited.

Several observations dictate that small sinus ostia as a consequence of nature are *not* the problem in the etiology of sinus disease. One is the aforementioned observation that the incidence of sinusitis is not more commonplace or even epidemic, given the universality of the small openings. It is accepted that the insults upon the upper respiratory tract and therefore the ostia are considerable, especially in a developed society. The ostia of the sphenoid and posterior ethmoid have the most exposure to industrial pollution and other airborne factors suspected to cause sinusitis but are most often the last to develop clinical disease, if at all.

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Sinus ostia appear to have an inherent resistance to insults and, even when involved, demonstrate a remarkable ability to remain functional (Fig. 1). An alternative consideration is that the sinus itself has an as yet undefined threshold of tolerance for a compromised ostium. In either case, when there is clinical evidence of sinusitis and medical treatment is given, it is doubtful that the physician's intervention is ostium specific. Nevertheless, medical therapy is highly effective against most episodes of sinusitis. Where, then, is the therapeutic effect of medical intervention? One possible answer to this question and the rationale for a minimally invasive surgical approach to medical failures are addressed in this article.

As noted previously, it is well known that the sphenoid and posterior ethmoid sinuses are commonly spared remarkable involvement, even in the presence of extensive anterior disease. Like ostia of other sinuses, their ostia are small, but mucus exiting from both the sphenoid sinus and the posterior ethmoid sinus complex flows directly into the nasal cavity. The sphenoid *sinus* empties into the sphenoethmoidal recess, an ill-defined nasal space of varying proportions. The sphenoid *ostium*, although not always easily accessible, can usually be visualized at surgical endoscopy and may be seen during routine office endoscopy. Posterior ethmoid drainage, although somewhat variable, usually has a direct entry into the nose through the superior meatus. The opening may also be visualized by endoscopy during surgery or during routine office examinations. In both instances, there is little in the way of a transition space from the ostium into the nasal cavity proper.

In contrast, mucus exiting from the maxillary sinus ostium flows into the infundibulum, a narrow, mucous membrane–lined transition space. The ethmoid bulla drains, not anteriorly, into the infundibulum, but posteriorly, into the hiatus semilunaris posterioris. This mucous membrane–lined transition space is anterior to the basal lamella, and the drainage from the bulla exits into it medially, toward the middle turbinate at the posterior aspect of the bulla. The bulla's transition space (not the ostium) is directly exposed to the potential insults that may traverse the middle meatus, a recognized explanation for the observation that sinus disease tends to originate in the anterior ethmoid.[3] Even more exposed is the interface

Figure 1. CT scan reveals ostiomeatal complex disease disproportional to maxillary sinus findings.

between the ethmoid bulla and the middle turbinate, as shown elsewhere in this issue. Because the ostium and its transition space are located at the posterior aspect of this interface, closure could be a precipitating factor in disease.

Although variable in drainage pattern, the frontal sinus also drains into a mucous membrane–lined transition space rather than directly entering the nasal cavity. The space is most narrow when egress is posterior and medial to the agger nasi cell, or when it becomes "constricted and sinuous due to the encroachment of some of the frontal anterior ethmoidal cells."[9] Although the actual ostium is small, the cleft into which it drains is quite variable in size, determined by the degree of development or the configuration of the agger nasi cell and the superior attachment of the uncinate process. The transition space for the frontal sinus is the most protected of the anterior sinuses, and the frontal sinus is the least often involved of the sinuses anterior to the basal lamella. The relative absence of disease may be a function of less common narrowing of the transition space, its lack of exposure, or both.

The anterior sinuses most often involved in clinical disease drain, not into the nasal cavity proper, *but into a mucous membrane–lined transition space that subsequently empties into the nasal cavity.* In the instances of the maxillary sinus and ethmoid bulla, the clefts into which they drain are quite narrow, predisposing to an approximation of the mucous membranes if an edema-producing insult occurs. The same predisposing situation exists in the frontal sinus drainage pathway if the posterior wall of the agger nasi cell or other cellular development narrows the transition space.

It is possible, therefore, that the small ostia of the maxillary sinus, ethmoid bulla and frontal sinus are *not* the predisposing factors to clinical disease but, rather, the narrow mucous membrane–lined clefts into which they drain. Although this concept of the pathogenesis of sinusitis is a long-standing and basic premise of functional endoscopic sinus surgery,[13, 14] the most commonly performed surgical intervention usually includes both the transition space and enlargment of the sinus ostium, particularly when the latter appears abnormal.[4–6]

Such intervention upon the ostia, although commonly therapeutic, may not be necessary. Particularly in routine cases of chronic sinusitis, the most common indication for surgery—simply making the spaces into which the ostia drain a part of the nasal cavity—might well suffice, converting their drainage to resemble that of the sphenoid and posterior ethmoid sinuses. This simple marsupialization has the theoretic possibility of making the anterior sinuses more resistant to, and better able to cope with, clinical disease. Such a *minimally invasive technique,* if effective, would have obvious appeal for both the surgeon and the patient.

It is also probable that *medical therapy* exerts its beneficial effects, not specifically upon the ostium of the involved sinus, but in a more general way upon the transition space into which it drains. Given the high rate of success of medical intervention in spite of a small and often diseased sinus ostium, the implications for a more limited surgical approach that also obviates enlargement of the sinus ostia are clear. *Any* enlargement would imply a "large hole" theory of intervention (Fig. 2) whereas not enlarging the ostia but dealing only with its transition space is a "small hole" approach.

Functional Considerations

The *ultimate* functional success in sinus surgery might well be similar to that obtained in effective medical therapy: an intervention that preserves the anatomic structures of the nasal cavity and lateral nasal wall and provides just enough

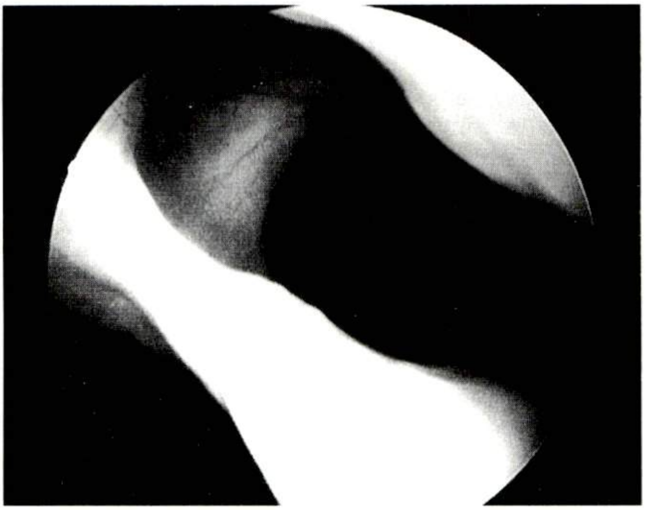

Figure 2. Large quiescent middle meatal antrostomy.

relief to initiate a return to health. Ideally, the sinus in question would return to balanced ventilation and drainage (with an intact ostium) as in medical therapy (Fig. 3).

With such a minimally invasive intervention, all of the technical problems and bleeding associated with making a "large hole" would be obviated. A potential cause of revision surgery would be eliminated. Any concerns about postoperative pooling or dumping from the opened cavity or the long-term effects of marsupialization, such as changes in oxygen tension, lymphatic drainage, and the unknowns of direct exposure of sinus linings to environmental elements and their toxins, would disappear. Finally, the instruments required to make the "large hole" would seldom be necessary.

Most discussions of the role of the turbinates in the pathogenesis of sinus disease evoke more heat than light. There appears to be no rationale for implicating the nasal turbinates in the etiology of sinus disease except to the extent to which they compromise the critical spaces in question. The turbinates are best seen in the context of the general health and function of the respiratory tract rather than as players in sinus disease. It appears that their proximity to the disease has resulted in a verdict of guilt by association with no clear evidence of culpability.

What constitutes a "diseased" turbinate or exactly how its removal contributes to the health and well-being of a patient are not clearly explained by the proponents of surgical removal. If the turbinates serve useful purposes, what are the compensatory mechanisms that substitute in their absence? The absence of a remedy for the complaints of patients who have lost their "turbinate reserve" as a consequence of aggressive turbinate reduction or removal dictates against an arbitrary decision regarding such surgery. Is turbinate removal for the convenience of the surgeon, or is there an as yet undefined benefit to the patient? Might turbinate excision be viewed as a legitimate effort to compensate for the lack of precision in sinus surgery and the scarring secondary to such a traumatic procedure? Have the same risk versus reward considerations been applied to turbinate surgery that are required in other surgical interventions, or is excision capricious

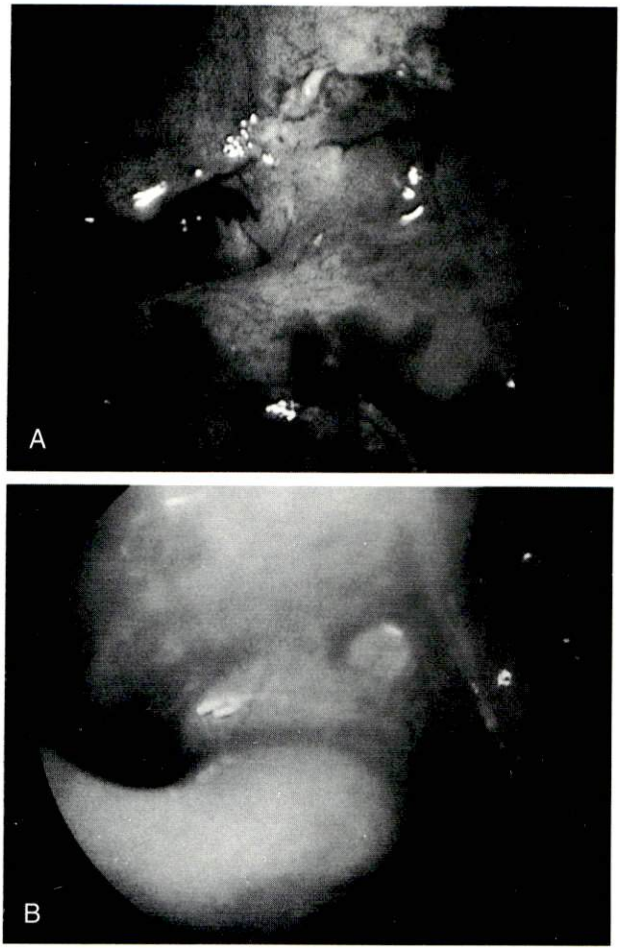

Figure 3. *A*, Immediate postoperative left maxillary sinus ostium, final common pathway, and exit of infundibulum. The ostium is obscured by disease. *B*, Same, two weeks postoperative.

and without a sound surgical rationale, continuing a tradition and perpetuating a myth?

Following the author's initial experience with the Hummer (see elsewhere in this issue), a study was initiated in February of 1993 to explore the limits of minimally invasive sinus surgery as it applies to the ostium of the maxillary sinus and the drainage pathways of the ostiomeatal complex. The idea that one could and should leave the maxillary sinus ostium alone if it appears unremarkable may be neither new nor profound. The possibility of benign neglect of the ostium in a diseased state, although alluded to in the literature,[5, 14] contradicts both traditional and current "large hole" surgical philosophy and has not heretofore been addressed specifically for the maxillary sinus. Unfortunately, the ostium, whether diseased or not, is not always seen by the surgeon, effectively eliminating the opportunity to make a judgment regarding its disposition. How to find the maxillary sinus ostium and to apply the concepts of the minimally invasive technique as a routine approach, along with the preliminary supporting evidence, follows.

THE TECHNIQUE

Fifty consecutive patients, both pediatric and adult, received preoperative topical oxymetazoline (0.05%) followed by a cocaine and epinephrine mixture. A double-blind study of cocaine, 4% and 10% with 1:50,000 epinephrine, was done for the purpose of assessing the systemic effects of the preoperative regimen. Baseline blood pressure and heart rate were obtained and a record of changes made after each application. The baseline systolic blood pressure was compared with the last measurement, and the increase or decrease noted. The heart rates were compared in the same manner.

The oxymetazoline was delivered out of its over-the-counter container. An average *total* volume of 1 mL was delivered in three doses at 5-minute intervals. The cocaine-epinephrine mix was delivered from an atomizer containing 8 mL of 10% cocaine and 0.16 mL of 1:1000 topical epinephrine (1:50,000 dilution). The total volume was *never* used in children or adults but was necessary to "charge" the atomizer for optimum flow. An average total volume of 1.4 mL was delivered in three doses also given at 5-minute intervals.

Under no circumstances should the cocaine-epinephrine mixture be administered concurrently with the oxymetazoline or given alone without pretreatment with oxymetazoline. Although the dosages of cocaine are above what the literature recommends, observations in previous studies were made without prior vasoconstriction.[12] Vasoconstriction produced by the oxymetazoline seems to dramatically reduce the absorption of the cocaine-epinephrine mixture, as demonstrated by quite benign responses in both blood pressure and heart rate (Table 1).

This regimen provides a predictable, intense vasoconstriction without significant systemic side effects and allows the surgeon to operate without delay. The reader should note that the changes in vital signs for the pediatric patients are predictable only for the increase in heart rate following the cocaine-epinephrine mixture, and that the increases are in an acceptable range. No significant differences in response were observed with respect to the cocaine concentration.

In this series, 14 of the 50 patients (28%) were in the pediatric group, aged 6 to 20 years, and no changes in methodology were made for age (Table 2). Twelve children received 1.8 mL or less, and 2 children received more—2.0 mL (age 6) and 2.4 mL (age 9)—all without incidence. Ninety percent of the time, all sprays and measurements were completed before the preoperative IV sedation was given. Thirty-six patients (72%) received surgery under monitored sedation anesthesia, and 14 (28%) under general anesthesia. Halothane anesthesia was not used.

Table 1. BLOOD PRESSURE AND HEART RATE RESPONSES FOLLOWING USE OF OXYMETAZOLINE AND COCAINE-EPINEPHRINE FOR VASOCONSTRICTION BEFORE SINUS SURGERY

	Blood Pressure (mm Hg)		Heart Rate (beats/min)	
Agent	Average Increase	Average Decrease	Average Increase	Average Decrease
Oxymetazoline	5	10	9	18
Cocaine-epinephrine	9	7	10	0

Three intraoperative injections of lidocaine 1% with epinephrine 1:100,000 are given, but none along the planned surgical route to the middle meatus, a precaution taken to minimize subsequent soiling of the endoscope with blood. The *total* dose of lidocaine should not exceed 7 mg/kg,[11] even though there is an interval in surgery between the first and second sides in bilateral surgery.

The first lateral nasal wall injection of 1% lidocaine with 1:100,000 epinephrine is delivered at the root of the attachment of the middle turbinate near the agger nasi (Fig. 4). A 25-gauge spinal needle with its tip slightly bent is advanced ahead of the endoscope toward the injection site. A brief systemic response is expected and dictates the pace of the remaining injections. The second injection is directed posteriorly toward the sphenopalatine vessels, the needle entry taking place at the inferior midportion of the middle turbinate (Fig. 5). Occasionally, a transient paradoxic bradycardia may occur with either or both of the intranasal injections. After the middle meatus is packed with 0.5-inch new gauze damp with the residue cocaine-epinephrine mixture, the third and final injection is made transorally with a 25-gauge 1.5-inch needle placed no more than 25 mm into the greater palatine foramen. Pre-injection of the second side is strongly discouraged, because more not less bleeding results secondary to rebound.

The middle turbinate is considered a part of the surgical approach only when it limits access to the middle meatus. Turbinate surgery is limited to a powered removal of attached polyps or the lateral portion of a concha bullosa (Fig. 6). Occasionally, as in an extreme lateral or paradoxic turbinate, powered removal of minimum lateral turbinate mucosa, 1 to 2 mm, may be required to access the middle meatus. The 2.5-mm aggressive cutter blade may facilitate this step. The limited resection and the resulting stable turbinate are preferred over a medial displacement, which invites a "floppy" turbinate. A horizontal resection of the middle turbinate is *never* required for access, even in the smallest pediatric noses.

Utilizing a 0-degree endoscope, the hiatus semilunar inferioris and *exit of the infundibulum* (Fig. 7) are identified. The latter is a reliable anatomic landmark routinely found at the most inferior portion of the semilunar hiatus. The uncinate process and the face of the ethmoid bulla are identified, note being made whether or not there is a "tight" relationship that might dictate slight anterior displacement of the uncinate process to access the infundibulum. The medial wall of the bulla and its relationship to the lateral aspect of the middle turbinate should also be visualized.

Using a retrograde approach to the uncinate, first advocated by Parsons and modified by the author to preserve a portion of the inferior uncinate for later dissection, a rough cut is made in the lower midportion of the uncinate process with a pediatric backbiter (Micro-France, Montreal, Canada [MCEN 27.2]) (see Fig. 7). The cut edges are then cleaned by powered instrumentation with only slight enlargement to create a "window" or infundibulotomy (Fig. 8). Ultimately, the uncinate cut must extend to the anterior limits of the infundibulum, sparing the lacrimal system.

With a 30-degree endoscope, the infundibulum may then be examined through the window for severity of disease. Medial and inferior retraction of the lower residual uncinate reveals the *final common pathway* of the infundibulum, between the exit of the infundibulum and the maxillary sinus ostium. If one tracks anteriorly from the exit along the final common pathway either visually or with a ball-tipped seeker, the oblique maxillary sinus ostium drops off inferiorly and laterally into the maxillary sinus.

The inferior uncinate bone may then be submucosally removed, and the two remaining membrane surfaces trimmed with powered instrumentation. Alternatively, the residual inferior uncinate may be taken down in full thickness by

Table 2. RESULTS OF USE OF PREOPERATIVE VASOCONSTRICTION IN 51 CONSECUTIVE PATIENTS UNDERGOING SINUS SURGERY (MARCH–JUNE 1994)*

Case	Pt Age (yr)	Pt Sex	Type Anesthesia Used†	Amt Oxy Used (mL)‡	Vital Sign Changes§ BP (mm Hg)	Vital Sign Changes§ HR (bpm)	ENT Solution‖ %	ENT Solution‖ Amt (mL) Given	ENT Solution‖ Total mg Given	Vital Sign Changes§ BP (mm Hg)	Vital Sign Changes§ HR (bpm)	Bleeding Time (sec)	History of Hypertension?	ENT Complete Before IV?¶	Surgeon Comments
1	43	M	Loc/sed	0.7	d 6	d 11	4	1.1	44	d 14	d 6	NA	No	Yes	Bleeding problems right side only; postop BID × 4.5 min
2	10	F	Gen	0.7	d 4	u 6	4	1.7	68	d 3	u 7	NA	NA	Yes	No problem
3	34	M	Loc/stdby	0.6	d 7	d 1	10	1.0	100	u 6	d 6	NA	No	Yes	More bleeding than 1st case, not troublesome
4	55	M	Loc/stdby	1.0	d 11	d 1	4	1.1	44	u 2	u 1	3.5	No	Yes	Bleeding troublesome, bilateral
5	47	F	Loc/stdby	2.1	u 6	u 5	4	2.1	84	u 20	u 4	3.5	No	Yes	Troublesome bleeding
6	36	M	Loc/stdby	0.9	u 15	d 9	4	1.0	40	u 1	d 6	6.0	No	Yes	No problem; did great
7	26	M	Loc/stdby	1.1	d 3	d 3	10	1.0	100	d 7	u 8	NA	No	Yes	No problem
8	6	F	Gen	0.8	u 3	u 2	10	2.0	200	u 16	u 8	NA	NA	Yes	No problem
9	10	M	Gen	0.9	d 1	u 17	4	1.0	40	u 15	u 15	NA	NA	Yes	Tympanomastoid done 1st delayed case; no problem; sl more than usual ped case
10	39	M	Loc/stdby	0.6	u 13	u 10	4	1.0	40	u 12	0	NA	No	Yes	Troublesome, not enough to prevent completing 8th, etc
11	25	F	Loc/stdby	0.6	d 2	u 11	4	2.0	80	u 13	u 7	NA	No	Yes	Troublesome bleeding
12	12	M	Gen	1.0	d 8	u 7	4	1.0	40	d 8	u 11	NA	NA	Yes	No problem w/bleeding
13	36	M	Loc/stdby	0.9	u 5	u 2	4	1.0	40	u 33	d 4	NA	No	Yes	No problem
14	9	F	Gen	0.9	d 36	d 14	4	1.0	40	d 14	u 2	NA	NA	Yes	Everything perfect
15	17	F	Loc/stdby	0.6	d 6	d 5	4	1.8	72	u 1	u 12	NA	No	Yes	No problem; ads under loc
16	34	F	Loc/stdby	0.9	(No vital signs)		4	1.0	40	(No vital signs)		NA	No	Yes	No problem
17	17	F	Gen	0.5	d 17	d 3	4	1.0	40	d 6	u 15	NA	No	Yes	No problem; rev case limited surgery
18	26	M	Loc/stdby	1.1	u 7	u 12	10	0.9	90	u 8	u 15	NA	No	Yes	No problem
19	7	F	Gen	1.1	u 3	d 11	10	1.0	100	u 3	u 9	NA	NA	Yes	Perfect

20	13	M	Gen	0.8	d 8	d 28	10	1.0	100	d 3	u 2	NA	No	Yes	Troublesome; not excessive bld; narrow nose; not as dry as previous 7 yr old
21	27	F	Loc/stdby	0.8	u 2	No data	10	1.4	140	u 2	u 21	6.5	NA	Yes	No problem
22	8	M	Gen	0.4	d 2	u 22	10	1.6	160	u 3	u 13	NA	NA	Yes	Troublesome; extreme polypoid disease; mucoid pus
23	52	M	Loc/stdby	0.8	u 8	u 6	10	2.0	200	u 14	u 6	NA	Yes	Yes	No problem
24	64	F	Loc/stdby	0.5	u 6	d 7	10	1.5	150	u 1	u 8	NA	No	Yes	No problem
25	38	M	Loc/stdby	1.5	u 5	u 2	10	2.2	220	u 2	u 20	NA	No	Yes	No problem; extensive polyps
26	47	M	Loc/stdby	0.7	d 11	d 3	10	2.5	250	u 17	u 19	NA	No	Yes	Perfect; no problem
27	26	M	Loc/stdby	1.2	d 9	d 2	10	1.0	100	u 6	Same	NA	No	No	No problem
28	20	F	Gen	0.7	Same	d 4	10	0.6	60	d 3	u 2	NA	No	Yes	No problem; septum resection
29	32	F	Gen	0.9	d 44	d 16	10	0.6	60	d 36	d 10	NA	No	Yes	No problem; revision minor tess
30	45	F	Loc/stdby	1.3	d 14	u 8	10	2.9	290	d 8	u 18	NA	No	Yes	Bleeding more than usual; not troublesome
31	9	F	Gen	1.5	u 4	Same	4	2.4	96	u 17	u 21	NA	NA	Yes	No problem
32	42	F	Loc/stdby	1.5	u 19	u 7	4	1.2	48	u 1	u 9	NA	No	Yes	No problem
33	81	F	Loc/stdby	2.4	d 1	u 5	4	1.8	72	Same	u 2	NA	Yes	Yes	No problem
34	43	M	Loc/stdby	1.0	u 2	u 5	4	0.75	30	u 3	u 8	NA	No	No	No problem
35	34	F	Loc/stdby	1.5	d 12	d 9	4	1.0	40	d 5	d 17	NA	No	Yes	No problem
36	42	F	Loc/stdby	0.8	d 3	u 2	4	1.9	76	u 8	u 5	NA	No	Yes	No problem; revision limited proc
37	61	F	Loc/stdby	0.9	u 2	u 1	4	2.0	80	u 13	d 2	NA	No	Yes	No problem
38	8	F	Gen	0.4	u 14	u 11	4	1.6	64	u 8	u 8	NA	NA	No	No bleeding
39	65	M	Loc/sed	1.2	d 9	d 10	4	1.0	40	u 8	d 4	NA	Yes	Yes	No problem
40	30	F	Loc/sed	1.1	u 8	d 20	4	1.0	40	u 28	u 8	4.0	No	Yes	More pain & bleeding than usual
41	35	F	Gen	2.2	d 9	u 2	10	1.0	100	d 3	u 9	2.5	No	Yes	No problem
42	75	M	Loc/stdby	0.9	d 8	d 8	10	0.9	90	d 7	u 2	NA	Yes	No	No trouble in spite ↑ BP during surgery
43	43	F	Loc/stdby	0.3	d 4	d 4	10	1.2	120	u 16	d 9	NA	No	Yes	Troublesome bleed; 4+; denies ASA, etc.

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Table 2. RESULTS OF USE OF PREOPERATIVE VASOCONSTRICTION IN 51 CONSECUTIVE PATIENTS UNDERGOING SINUS SURGERY (MARCH–JUNE 1994)* (*Continued*).

					Vital Sign Changes§		ENT Solution‖			Vital Sign Changes§					
Case	Pt Age (yr)	Pt Sex	Type Anesthesia Used†	Amt Oxy Used (mL)‡	BP (mm Hg)	HR (bpm)	%	Amt (mL) Given	Total mg Given	BP (mm Hg)	HR (bpm)	Bleeding Time (sec)	History of Hypertension?	ENT Complete Before IV?¶	Surgeon Comments
44	43	F	Loc/stdby	0.6	d 2	u 6	10	1.6	160	u 4	u 9	NA	Yes	Yes	More troublesome than previous 2 cases; ? ↓ vasoconstriction @ onset of OR
45	48	F	Loc/stdby	0.6	u 91	d 10	10	1.0	100	u 10	d 14	2.5	No	Yes	No problem; excellent visualization even with left FSP
46	69	F	Loc/stdby	0.3	u 4	u 2	10	1.0	100	d 10	d 2	4.0	Yes	Yes	Problem case; ASA daily
47	37	M	Loc/stdby	1.0	u 1	d 2	10	2.6	260	u 12	u 11	NA	No	Yes	Bleeding a problem; staged left side and completed all sinuses
48	33	M	Loc/stdby	0.8	u 7	d 4	10	1.6	160	u 15	u 1	NA	No	No	No problem
49	61	M	Loc/stdby	0.2	u 2	u 8	10	2.2	220	d 8	Same	5.0	No	Yes	No problem; on ASA
50	18	F	Loc/stdby	1.2	u 17	d 1	10	1.6	160	u 15	d 1	2.5	No	Yes	No problem; extensive septum
51	35	F	Loc/stdby	1.1	d 10	0	10	1.6	160	0	u 4	NA	No	Yes	No problem
Average				0.8				1.5							

* NA = not available or not applicable????.
† Gen = general; loc/sed = ???; loc/stdby = ???.
‡ Oxy = oxymetazoline (0.5%) given from over-the-counter container as Afrin spray
§ BP = systolic blood pressure; HR = heart rate; u = increase; d = decrease; 0 = ???.
‖ ENT = cocaine-epinephrine mixture delivered from an atomizer containing 8 mL of 10% cocaine and 0.16 mL of 1:1000 topical epinephrine (1:50,000 dilution) given in 3 doses at 5-minute intervals.
¶ Indicates whether all ENT spraying and vital sign measurements were completed before IV sedation was started.

Editor's note: This table contains data gathered from adults, which cannot be readily applied to pediatric patients; however, the table does contain ample data on this treatment in children, and I felt that the entire study was worthy of being shared with readers.

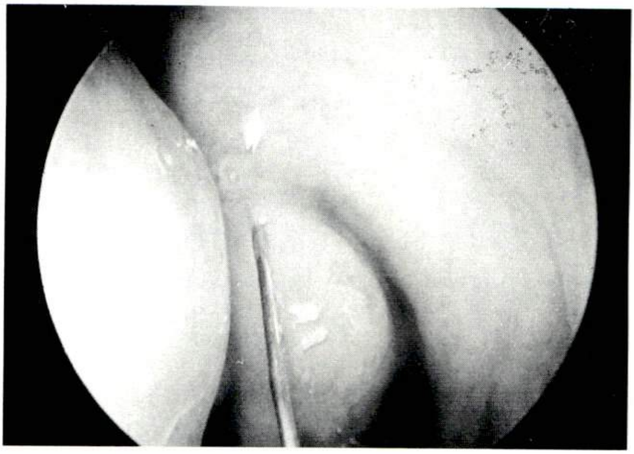

Figure 4. Initial intranasal injection using lidocaine 1% and epinephrine 1 : 50,000 at attachment of left middle turbinate.

powered instrumentation, with sparing of the final common pathway and the medial lip of the maxillary ostium. No instrumentation or removal of tissue from the ostium is required even if it is obscured by the disease process.

In most pediatric cases, a submucosal removal of the lower uncinate bone is both desirable and technically feasible. When this maneuver is precisely done, only a mucosal seam remains where the lower uncinate once was. Removal of the residual upper uncinate is reserved for visualization of the superior portion of the ethmoid bulla or accessing of the agger nasi cell for the purpose of assessing frontal drainage.

Using the described minimally invasive techniques and *without opening the maxillary sinus ostium,* the author has performed more than 300 *consecutive* procedures, in both pediatric and adult patients; pathology of the infundibulum has

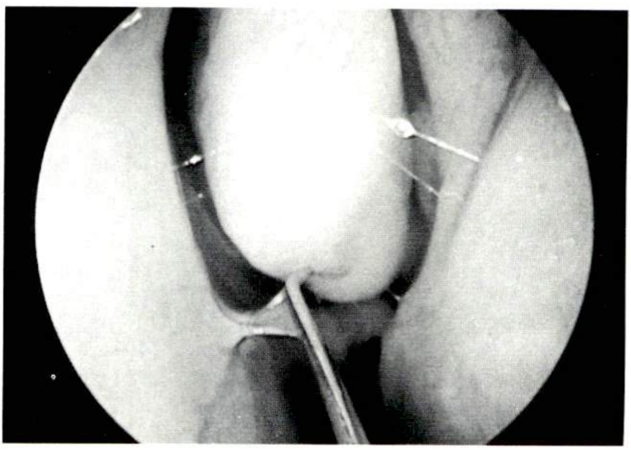

Figure 5. Second injection at midportion of left inferior middle turbinate.

Figure 6. Bivalved right concha bulla. Removal of lateral portion will open middle meatus.

varied from none to severe polypoid changes. Edema or obscuration of the maxillary sinus ostium (see Fig. 2) with or without polyps, pus, or cysts in the maxillary sinus was present in the majority of patients and was accepted.

Purulence within the maxillary sinus was sometimes irrigated clear via an inferior meatal puncture, but generally it was left alone. Massive antral cysts were evacuated by the same technique or left alone. Accessory ostia were considered clinically significant only if there was evidence of recirculation, i.e., foamy effusion on CT or direct operative observation. In either instance, the accessory and primary ostia were joined. Accessory ostia were otherwise accepted and were not surgically addressed.

No Caldwell-Luc procedures were performed for the removal of polyps or cysts, and no inferior meatal windows were made. All patients were drawn from a stable mid-western U.S. population with the follow-up ranging from 3 months

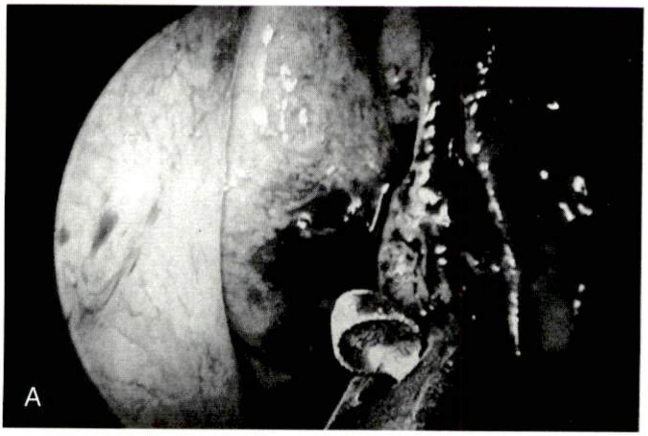

Figure 7. *A*, Backbiter approaching right semilunar hiatus (SLH). Partial view of residual concha bulla with retained mucous membrane is to the right.

Illustration continued on opposite page

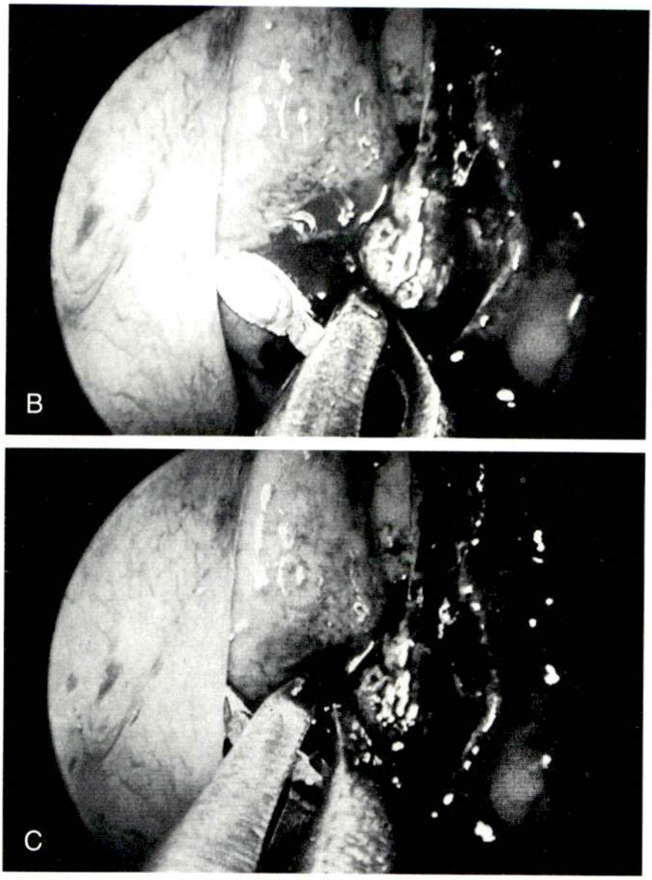

Figure 7 (*Continued*). *B*, Backbiter cup at SLH. Exit of infundibulum is just below the cup. *C*, Backbiter cup entering infundibulum. Closing the instrument will begin retrograde uncinate cut.

to 2 years. Even though it is well known that the vast majority of patients requiring secondary surgery are identifiable within the first few months after the first procedure, only 1 of the more than 300 patients in this series has needed revision of the maxillary sinus (0.3%).

The relative absence of secondary surgery for the maxillary sinus does not mean that revisions for disease at other sites have not been necessary. Many of the revisions, however, were done in patients treated early in the series and required only the simple removal of retained uncinate process anterior to the maxillary ostium for resolution of the difficulty. The author's overall revision rate has dropped from 15% to 7% since the adoption of the minimally invasive technique.

Prior to the author's adoption of this minimally invasive "small-hole" approach to the maxillary sinus ostium, postoperative complaints frequently centered on the opened maxillary sinus. Pooling and dumping of sinus contents at unexpected or inappropriate times was a concern, even in otherwise asymptomatic

Figure 8. Roughly cut uncinate "window" or infundibulotomy. A portion of the more anterior primary maxillary sinus ostium and an accessory ostium at the exit of the infundibulum are seen. The inferior uncinate bone is yet to be removed. The final common pathway is between the two ostia.

patients. Many patients with middle meatal antrostomies suffered recurrent and prolonged infection secondary to obstructing polypoid changes at the ostium, and they required prolonged medical therapy or one or more secondary procedures before their disease became quiescent. The drop in the overall revision rate in this series is secondary to the dramatic reduction in maxillary sinus revisions.

Whether or not patients who have undergone functional endoscopic sinus surgery that has left their maxillary sinus ostia intact will have higher or lower rates of postoperative sinus infections than patients who have undergone middle meatal antrostomy over the long term is unknown. What is known is that the threshold of surgery required for quiescence of maxillary sinus problems is far less than was previously thought necessary. The decision to enlarge the maxillary sinus ostium should not be dictated by either its pathologic appearance or the preoperative CT findings relative to the maxillary sinus itself. Preliminary observations also suggest that, whatever the revision rate proves to be, it will be lower than those in patients who had middle meatal antrostomy. The implications for other sinuses, particularly the frontal and sphenoid, are obvious.

CONCLUSION

A rationale and technique for operative sinus intervention are presented. The pathophysiology of sinus disease is not the function of a small sinus ostium but, as was first recognized by others, the mucous membrane–lined transition space into which the ostium drains. An explanation is given for the relatively uncommon involvement of the sphenoid and posterior ethmoid sinuses compared with the more susceptible anterior sinuses. A technique for opening the transition space of the maxillary sinus with no instrumentation of its ostium is detailed. This minimally invasive approach of "small hole" surgery obviates the necessity for a more traumatic "large hole" procedure and appears to support the original concepts of functional intervention. Advantages of the technique, including a dramatic decline in revision procedures, are discussed.

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