THE HUMMER

A Remedy for Apprehension in Functional Endoscopic Sinus Surgery

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Today's sinus surgery is relatively unchanged from that of the early 1900s in several respects, the most notable of which is that the surgery, particularly in children, is performed against a background of apprehension. The surgeon feels the long arm of the possibility of a poor outcome[7] and a place in the annals of the most litigious procedure in pediatric otolaryngology. The parents must be made to share this emotion with the surgeon to ensure informed consent. This emotion is not shared to the same extent in most other surgical procedures, but it has dominated the otolaryngology landscape since Mosher's observation in the early 1900s that "it has proved to be the easiest procedure with which to kill a patient."[1] It can hardly be debated that such a situation exists. The reasons for the dilemma and an attractive remedy are the thrusts of this article.

Sinus surgeons have been admonished to approach their task with the mindset of ear surgeons. Some parallels are clear: Both the otomastoid and paranasal sinuses are relatively small cavities with complex configurations surrounded by critical, even vital neighboring structures or organs. Ear surgeons, however, have been delivered from the fear of hammer-and-chisel days by a precision instrument—precision that makes the most difficult of cases routine in experienced hands with expected good outcomes and low morbidity. The precision of the mastoid drill and the progressive refinement in supporting instruments coupled with improved visualization have converted ear and mastoid surgery to an exercise of respect, not apprehension.

Clearly, the remedy for surgical anxiety is *precision*. The limitations of traditional instrumentation for pediatric sinus surgery are well known, and although improvements have been made in manual instruments, solutions to the problems of delivering a precise technique have been long in coming. Even modest bleeding during a procedure in a child's small nose demands that nearly as much time be devoted to keeping the operative field clear as to the operation itself. Not

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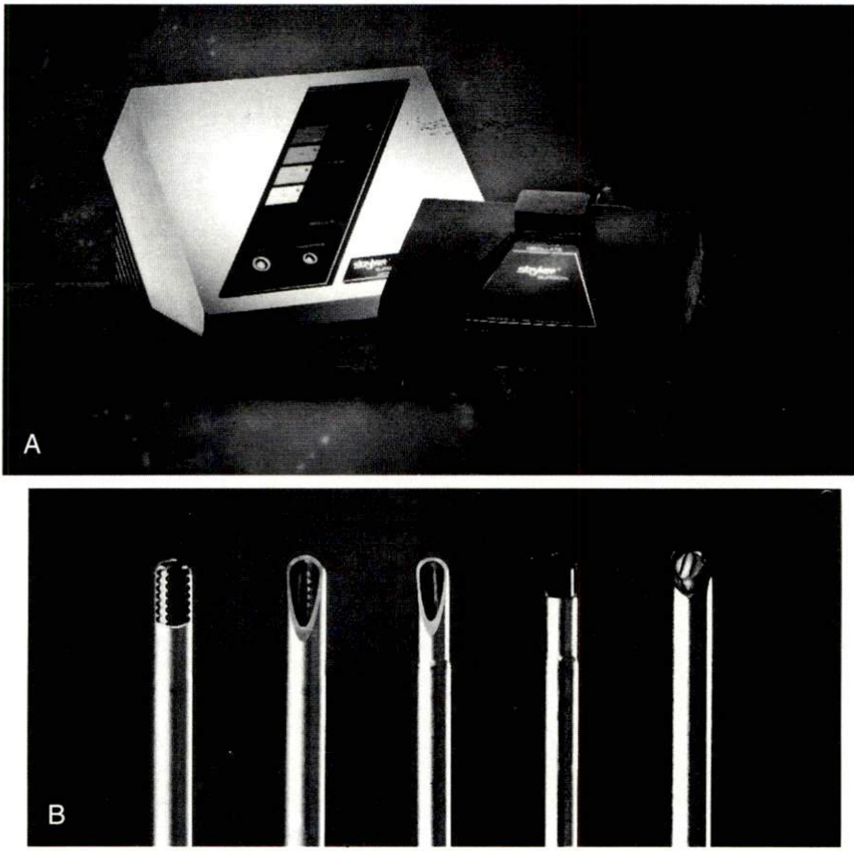

Figure 1. *A*, Power unit and foot-switch. The unit is most effective in the oscillation mode with fully depressed foot-switch. *B*, A variety of attachments is available. The 3.5 mm aggressive cutter is second from left.

Illustration continued on opposite page

infrequently, the compromise in visibility generates loss of confidence and may even lead to a wise decision to abort the procedure. This is only one of many issues that has gone unsolved and left the pediatric sinus surgeons at a technical disadvantage.

THE HUMMER

Since 1992, the author has successfully used a power instrument that addresses many of the critical issues confronting today's sinus surgeon.[6] More recently, multiple otolaryngologists, in both private practice and academia in the United States and abroad, have reported positive experiences with the device.[3] The author's initial work began with the utilization of the Hummer, a powered microdébrider manufactured by Stryker Endoscopy (San Jose, CA), designed originally for temporomandibular joint surgery. The off-the-shelf device has been and continues to be used for sinus surgery without modification.

Figure 1. (*Continued*) *C*, Handpiece with blade attached.

In spite of early struggles to determine tip selection, power settings, suction level, means of clearing clogged suction lines, and the extent to which the device would be effective for sinus surgery, the promise of a better way was evident early on. At its worst, this instrument provided advantages over traditional instrumentation; at its best, it now replaces most of the instrumentation the author formerly used for sinus surgery. As solutions to all the preceding variables are resolved regarding setup and application of the new instrumentation, the result is a precision instrument that addresses most of the troublesome issues that preclude the delivery of advanced state of the art sinus surgery. Today, if the instrument is not available, the author cancels sinus operations.

The complete surgical unit consists of a power unit and its foot-switch or pedal (Fig. 1*A*), a handpiece, and a disposable blade (Fig. 1*C*). The most effective blade is the aggressive cutter (Fig. 1*B*). It is small, with a diameter of 3.5 mm, and has benign contours that make it relatively atraumatic. A 2.5-mm aggressive cutter is also available for the particularly small or narrow child's nose. Each blade has two components, the outer portion being the sheath, and the inner the cutting blade (Fig. 2). The outside protecting sheath has a distal working port on one side on a bias that includes a small part of the tip. The cutting blade within the sheath has a window to match and teeth to cut. One of the important features of the instrument is a hollow shaft in the center of the inner cutting blade, which provides a channel for continuous suction to remove blood and resected tissue debris. This feature dramatically improves visibility for the surgeon. Further, precise removal of obstructing tissue and bone is possible without inadvertent peripheral damage or stripping of uninvolved mucous membrane.

Fortuitously, the handpiece of the Hummer was applicable to sinus surgery with no required modification, whether one was working through the endoscope or off the monitor. It accepts the cutting blade by way of a quick-lock mechanism and has a suction channel to receive the blood and debris delivered to it. A suction port on the proximal end accepts suction tubing and provides egress from the handpiece to the suction canister (Fig. 1*C*). Optional cloth baskets placed in the suction canister or specially manufactured traps may be used to enhance specimen collection.

Proper suction is critical for the effective use of powered instrumentation in the sinuses. Any decrease in effectiveness is most likely a result of some suction loss. A measurement taken at the point of the attachment of the suction to the handpiece should read 170 to 180 mm Hg. A hand-held gauge suffices for this purpose. The Stryker unit has a suction control on the handpiece that must be flush with and not angled from the handpiece, or suction will be diminished. Suction loss due to clogging problems is dramatically reduced if the tip of the cutter is placed in water or saline with the power on to clear blood and debris from the lines each time the cutter is removed from the nasal cavity.

Should clogging occur, the reduced effectiveness in cutter action is readily apparent. A suction set-up schematic is shown in Fig. 3. Clearing the handpiece blade assembly or the tubing going back toward the suction canister requires only the turn of a stopcock and a syringe flush. Irrigation of the tip is not possible if the cutter window is closed; therefore, the blade should be spinning during irrigation. Rarely is disassembly required for cleaning.

Four other variables may entrap the user into thinking the device is ineffective: First, other blade configurations are available for use with the handpiece, including burrs and shavers, but unless they are used with the understanding that they are not nearly as effective as the 3.5-mm aggressive cutter, discouragement ensues. Second, even though the power unit allows pure rotary action, either right or left, the oscillating mode is dramatically more effective. Third, unless the pedal is fully depressed, less than full power results in less than maximum effectiveness. Fourth, the point of contact of the operator's foot with the pedal must be accurate to generate full power.

THE POWERED APPROACH

A precise surgical technique is possible with the Hummer in almost every surgical procedure when the preceding variables are mastered, the device is properly set up, and training is obtained in both the application of powered instrumentation and the functional approach to endoscopic sinus surgery in children. Whether the problem is caused by severe polyposis or anatomic variations, even the most difficult sinus operation can usually be converted into a routine procedure. Polyps may be precisely removed, better defining the structures of the nasal cavity and middle meatus, usually without troublesome bleeding.

Once access to the middle meatus is achieved, a step-by-step surgical approach can be implemented, not unlike that in mastoid and ear surgery, progressing systematically as the anatomy unfolds. Even the most recent manual "cutting" instruments fall short of the precision and control possible with powered instrumentation. More precision and less peripheral damage mean less bleeding than with manual instruments. If bleeding occurs, blood is removed from the surgical field in real time, improving visibility and reducing apprehension for the surgeon, not to mention the obvious decreased risk for the child.

Although the use of powered instrumentation is no substitute for good training and experience in sinus surgery, it can dramatically elevate the level of sinus surgery. Full realization of the benefits of the approach can be obtained only by a surgeon with underlying knowledge of the anatomy and pathophysiology of the nasal cavity and paranasal sinuses. Futher, every possible effort should be made to prepare the child and operative setting to keep troublesome bleeding to a minimum. An effective preoperative vasoconstrictive routine is detailed elsewhere in this issue.

The middle turbinate is a problem for the powered endoscopist only to the extent to which it limits access to the middle meatus. With the nonbiting side of the outer sheath, the lower middle turbinate can be pushed gently toward the septum without mobilizing it. The biting surface is facing the surgical site, and the middle turbinate can be preserved with its mucosa intact. If the middle turbinate is thick and interfering with the surgical approach, the smaller-diameter, 2.5-mm aggressive cutter may be used.

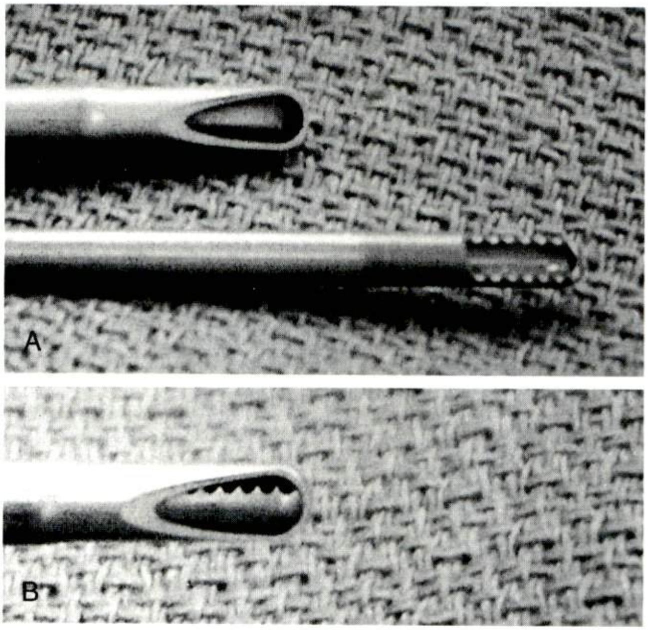

Figure 2. *A*, Tips of sheath and blade of 3.5 aggressive cutter, unassembled. *B*, Assembled. Real time continuous suction is provided to the cutter window through the hollow shaft of the blade.

An alternative is a very minimal powered removal of the lateral turbinate mucosa. This usually resolves the difficulty *without* a more aggressive resection of the middle turbinate, a procedure generally discouraged in functional surgery and particularly in children. If a concha bullosa is present, the lateral half may be "hummed" away or removed with a "bivalve" technique (illustrated in article on minimally invasive technique). Care must be taken to preserve the medial mucous membrane inside the residual concha. The outflow tract of the concha bullosa should be identified and opened to communicate with the entire dissection.

FINDING THE MAXILLARY SINUS OSTIUM

Following the recommended preoperative nasal vasoconstriction and intraoperative injections, a 0-degree endoscope is used to visualize the uncinate process, ethmoid bulla, semilunar hiatus, and exit of the infundibulum (the most inferior portion of the semilunar hiatus). With the introduction of a backbiter (Micro-France, Montreal, Canada [MCEN 27.2]) through the semilunar hiatus near its mid-portion, a retrograde cut in the lower midportion of the uncinate process initiates the creation of a Parsons window into the infundibulum (Fig. 4). A submucosal resection or powered removal of the inferior portion of the uncinate process in full thickness allows visualization of the maxillary sinus ostium. Care must be taken to extend the initial uncinate cut to the anterior limits of the infundibulum. This is all that is required to address maxillary sinus disease, in a technique detailed elsewhere in this issue.

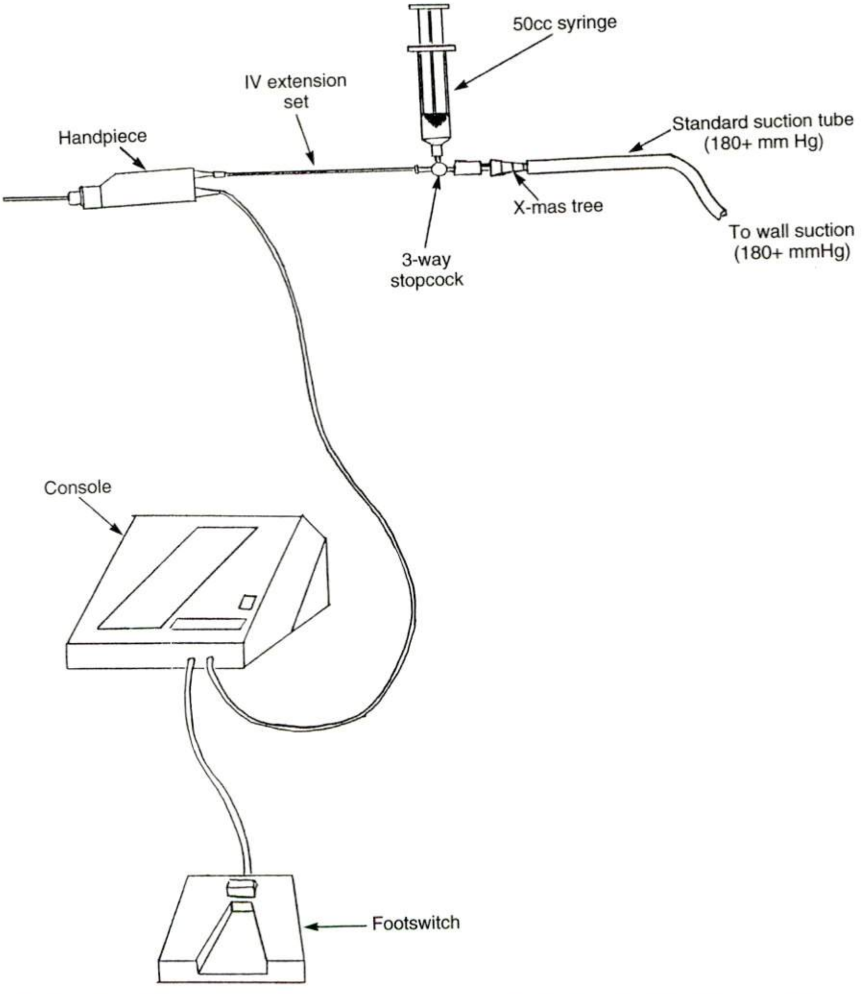

Figure 3. Suction control set-up for microdebrider system. Commercial products are also available and are recommended, particularly to replace the components between the handpiece and suction tubing.

ANTERIOR ETHMOIDECTOMY

A precise identification and functional dissection of the bulla ethmoidalis are possible with powered instrumentation. If the backside of the blade is placed along the lateral side of the lower middle turbinate, with slight medial displacement of the turbinate, the interface between the medial wall of the bulla and the middle turbinate are revealed (Fig. 5).

Opening the bulla from medial to lateral both preserves the basal lamella as a future landmark and begins the anterior ethmoid dissection with the least risk to the lamina papyracea (Fig. 5). Small plates of ethmoid bone may emerge as the instrument is dissecting laterally, delaying entrance into the bulla itself. As a result of the inability of the cutter to obtain an edge to pull the bone into its window, the

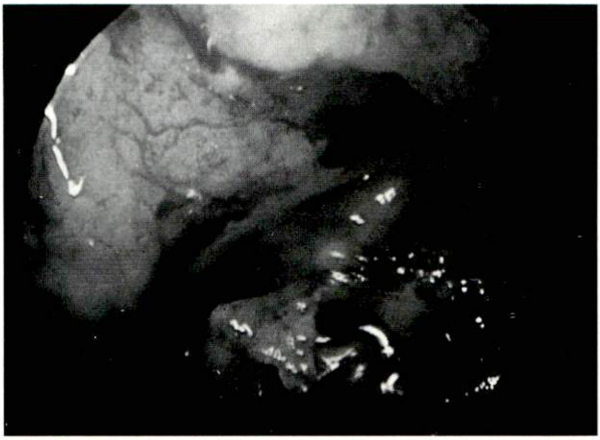

Figure 4. Left uncinate "window" or infundibulotomy. Portions of both the oblique primary maxillary sinus ostium and the accessory ostium at the exit of the infundibulum are seen. The final common pathway is between the two ostia. Inferior uncinate bone to be resected or powered down is shown.

plates are pushed laterally ahead of the blade tip submucosally. Removing such bony plates with pediatric forceps facilitates the operation and allows a dramatic "humming" of the exposed medial mucous membrane without stripping the bulla and lamina papyracea to bare bone. The limited anteroposterior dimension of the ethmoid bulla is a surprising finding, particularly in pediatric cases (Fig. 6).

Just as it is important to identify the natural ostium of the maxillary sinus, it is equally necessary to include the natural ostium of the ethmoid bulla in the powered dissection. The ostium is found behind a band of mucous membrane at the most posteromedial portion of the bulla, anterior to the basal lamella (Fig. 7). A direct entry into the face of the bulla increases the possibility of leaving the medial wall of the bulla and overlooking this surgical step. Only when there is

Figure 5. Uncinate "window," face, and medial wall of left ethmoid bulla. Approach to medial wall/middle turbinate interface with Hummer.

Figure 6. Ethmoid bulla dissected from medial to lateral to expose basal lamella. Note the limited anterior-posterior dimension of the bulla.

a need to decompress the orbit or drain a subperiosteal abscess would the lamina papyracea be skeletonized.

In the majority of pediatric cases, no further surgery is required. This operation is referred to as a "mini-FES" procedure.[3,7] The use of powered instrumentation expedites the procedure, reduces blood loss, makes a safer approach for the child, and reduces apprehension for the surgeon. To this point in the operation, only four instruments have been required: a backbiter, the microdébrider, a pediatric forceps, and a ball-tipped seeker.

POSTERIOR ETHMOIDECTOMY

If the preceding operation has been carefully done, the vertical portion of the basal lamella is now visible (Figs. 6 and 7*B*). It may be minimally or extensively pneumatized. The blade tip allows a controlled entry into the posterior ethmoid complex. The tip's benign contours, precision cutting action, and small size reduce dramatically the potential for a surgical accident in knowledgeable and experienced hands. A preliminary opening made by a straight pediatric forceps sometimes facilitates entry. Simple inspection or clearing of cells to the base of the skull is possible without stripping of mucous membranes and bony exposure. Manual removal of bony plates is not often required but may be helpful. Removal of soft tissue with forceps is rarely necessary.

FRONTAL SINUS DRAINAGE

Should there be questions about or an indication for investigating the status of frontal sinus drainage, the powered approach to the frontal sinus is through the residual upper uncinate process, an as yet undisturbed portion of the structure if a Parsons lower uncinate window is made. The full thickness of upper uncinate may be "hummed" away, aided by the occasional removal of bony plates of the uncinate process with a 0-degree or 90-degree pediatric forceps. As with the

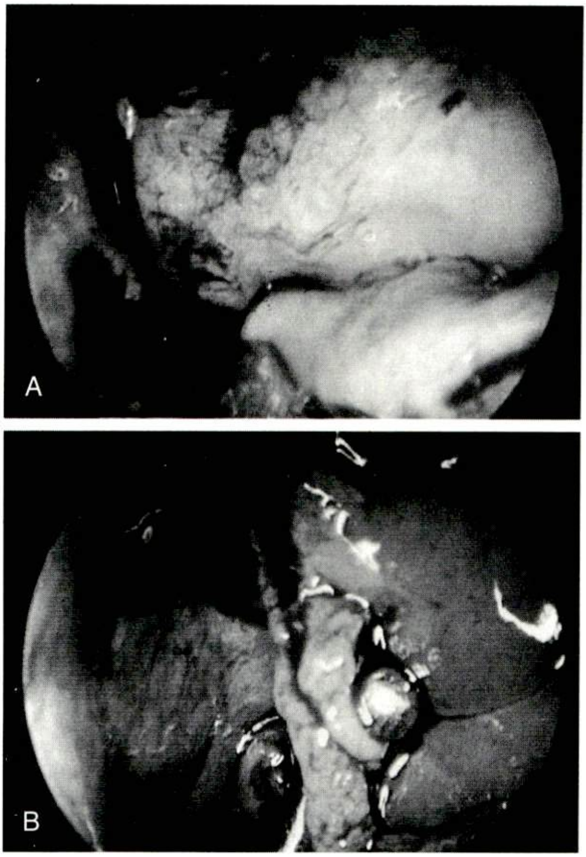

Figure 7. *A*, Face of left ethmoid bulla with inferior uncinate retracted to reveal exit of infundibulum, final common pathway, and maxillary ostium (bubble). The middle turbinate/bulla interface is to the left. *B*, The posterior wall of diseased left bulla with seeker in ostium of bulla. Basal lamella is left-center; middle turbinate is left.

ethmoid soft tissue, the mucosa on both sides of the uncinate is easily consumed with the Hummer.

Invariably, the mucous membrane of the floor of the agger nasi cell comes into view simply with removal of the most superior uncinate. Powered instrumentation reliably and atraumatically locates and defines this cell (Fig. 8*A*), a crucial step in a minimally invasive approach to the frontal sinus. As small bone fragments are teased away, a larger opening is created, allowing visualization of the dome of the agger nasi cell with a 30-degree endoscope. During this dissection, the cutting side of the instrument must be directed superiorly and laterally, but *never medially* toward the root of the middle turbinate, to minimize the risk of a cerebrospinal fluid leak.

When indicated, the search for where the frontal sinus drains should be directed posterior and medial to the agger nasi cell (Fig. 8*B*), an invaluable anatomic finding also emphasized by Parsons elsewhere in this issue. Simply retracting the posterior wall of the agger nasi cell forward may reveal the otherwise

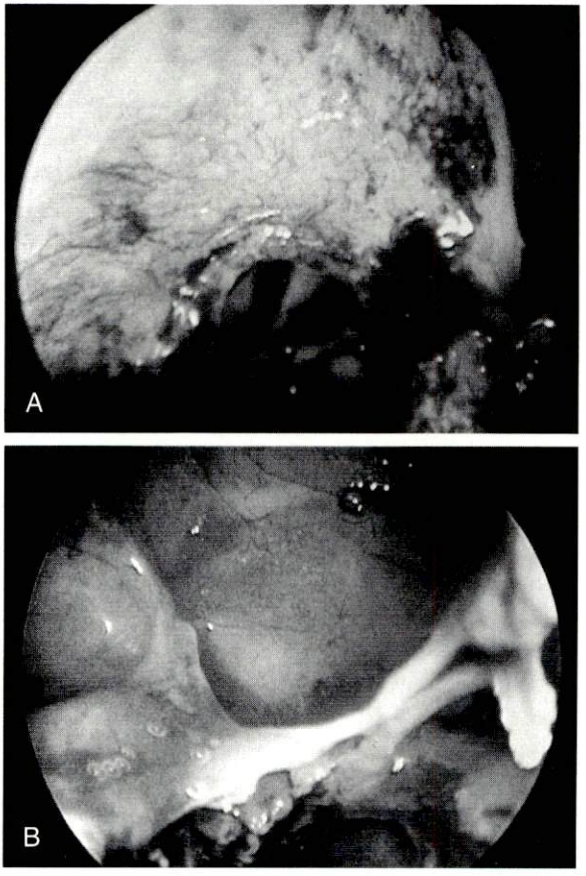

Figure 8. *A*, Right agger nasi and agger nasi cell (0° scope). *B*, Right agger nasi cell (30° scope). Approach to frontal drainage at 3 o'clock (posterior and medial to agger nasi cell).

hidden exit of the frontal sinus and also may be therapeutic, with no further dissection being required. Powered removal of the posteromedial portion is usually possible if there is a need to remove diseased tissue. The dissection is accomplished moving from medial to lateral, until the space posterior to the agger nasi cell develops or the dome of the cell (i.e., floor of frontal sinus) is reached. That usually coincides with entry into the frontal sinus and may require other than a powered approach. Aggressive removal of the dome of the agger nasi cell is seldom required.

FINDING THE SPHENOID OSTIUM

The 8-cm length, small diameter, and benign contours of the Hummer blade make it ideal for a direct approach to the sphenoid sinus ostium with less fear of a catastrophic event. In the absence of fungal disease or unusual skull base pathology, there appears to be no compelling reason that surgery of the sphenoid sinus should extend beyond clearing the sphenoethmoid recess, the sphenoid ostium, or both. If one proceeds between the middle turbinate and septum on a line between the anterior two thirds, and posterior one third of the superior turbinate, a direct powered approach to the sphenoid face will usually allow both visualization and clearing of the sphenoid ostium. Lateral displacement of the superior turbinate is occasionally required. After diseased tissue is removed from the face and ostium of the sphenoid, enlargement of the ostium itself is usually limited to the inferior portion, if required at all, and may readily be performed with the Hummer.

OTHER BENEFITS OF THE HUMMER

The same precision that gives confidence to the surgeon confers benefits on the child. Continuous, real-time suction dramatically reduces the necessity of moving instruments in and out of the nasal cavity. The result is less trauma and therefore less bleeding. Less trauma and the ability to leave mucous membrane at the limits of the dissection dramatically reduce the healing burden for the child and the time required for complete healing to occur.

Early recommendations for local anesthesia surgery were made for the stated purpose of using the patient as a monitor to reduce the risk of the procedure. Many surgeons, however, found a low patient acceptance of this recommendation, in addition to its obvious limitations in children. Further, the lack of precision, patient discomfort, continuous pooling of blood in the nasopharynx, and absence of continuous suction gave many surgeons a bias toward general anesthesia.

The use of powered instrumentation increases the appeal of monitored local anesthesia surgery for both selected adolescents and adults. Continuous suction obviates the necessity for a nasopharyngeal pack. More precision means less morbidity for the patient during the procedure. Better visibility and the prospect of an anatomic dissection are confidence builders for the surgeon. Outpatient surgery in a clinic setting, as in simple polypectomy and lysis procedures, are also quite feasible with use of the Hummer.

CONCLUSION

A powered instrument is now available for pediatric functional endoscopic sinus surgery. Armed with a functional approach to endoscopic sinus surgery and experience with powered instrumentation, a *precise, minimally invasive* surgical technique is possible. The approach addresses most of the troublesome issues that have characterized sinus surgery for decades and heralds a new horizon in instrumentation for nasal and sinus surgery, particularly in children.

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