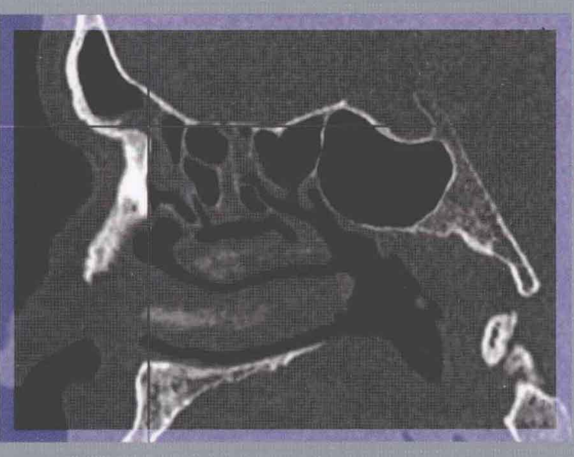
Endoscopic Sinus Surgery

Anatomy, Three-Dimensional Reconstruction, and Surgical Technique

Peter-John Wormald

Includes CD-ROM



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Peter-John Wormald, M.D., F.R.A.C.S., F.C.S. (S.A.), F.R.C.S., M.B.Ch.B.
Professor and Chairman
Department of Otolaryngology
Adelaide and Flinders Universities
Adelaide, Australia

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Dedication

Dedicated with love to Fiona, my wife, without whom this book would not have been possible
and Nicholas and Sarah, my children who provide my inspiration

Foreword

P. J. Wormald has become one of the leading rhinologists internationally. His hallmarks are his tireless energy, continual ongoing research, and excellent teaching. As a result, he is in demand across the world as a lecturer and course instructor. When I attended his course in Adelaide, I was particularly impressed by his ability to teach the detailed anatomy of the ethmoid sinuses, and in particular the frontal recess, to the participants. He achieved this by having them conceptualize the anatomy from the CT scans and then draw the relevant anatomy. As a result, the course participants really started to visualize and conceptualize this complicated anatomical region for the first time.

In this book, Professor Wormald draws heavily on his extensive teaching experience at courses and from within his own otolaryngology training program. In the illustrations and in the accompanying video clips, he clearly elucidates the anatomy in a way that makes it easy for the reader to conceptualize and learn. He demonstrates his endoscopic surgical techniques and presents all the key points of operative surgical procedures.

I believe that this book will be of particular value to residents as well as to practicing otolaryngologists who wish to further advance their knowledge within the field of sinus surgery. The clear concise illustrations bring the key points across clearly and in a manner that makes them easy to remember. It is a very worthwhile addition to the previous texts within the field and should enhance the endoscopic surgical technique of those who review it.

David W. Kennedy, M.D., F.R.C.S.I.
Rhinology Professor and Vice Dean
University of Pennsylvania

Preface

Endoscopic sinus surgery (ESS) is a relatively new method of performing sinus surgery. In the past, sinus surgery was performed either with the naked eye or with a microscope and usually through an external incision. The major advance that preceded ESS was the development of the Hopkins rod telescope, which allowed a clear and magnified view to be obtained inside the nose and sinuses. By using telescopes with angulated ends, it was possible to view anatomy or pathology around corners and in recesses. The second advance in the development of ESS was the concept of re-establishing the normal physiological function of the diseased sinuses by restoring the patency of the natural sinus ostium in the maxillary, frontal, and sphenoid sinuses and by the removal of diseased ethmoidal cells. As this form of surgery has progressed, so too have the number and complexity of the operations that can be performed using telescopes. These now include a large number of ancillary procedures, including sphenopalatine artery ligation, Vidian nerve neurectomy, dacryocystorhinostomy, orbital decompression, optic nerve decompression, closure of cerebrospinal fluid leaks, and benign and recently malignant nasal and sinus tumor removal.

Although telescopes give the surgeon a clearer and magnified view of the nose and sinuses, the picture on the video monitor is not three-dimensional, and depth perception and orientation can be difficult. Consequently there is a risk of getting lost and this may result in injury to the orbit, its contents, the optic nerve, and the intracranial cavity.

To reduce this risk, surgeons should ensure that they are thoroughly familiar with anatomy and the anatomical variations that can occur in the nose and sinuses. This textbook and CD ROM emphasize the thorough understanding of the anatomy as the base on which all the presented surgical techniques are built. The central theme that runs through the chapters in this book is the creation of a three-dimensional mental image of the anatomy from the computed tomographic (CT) scans. This should allow the surgeon at any point during the operation to turn to the CT scans and point out on the scan the exact cell that is currently being dissected. Although this may initially be challenging, we have found that repetition improves the surgeon's abilities to create such a three-dimensional picture and results in a marked improvement in the understanding of the anatomy at the time of surgery. Image guidance instruments being available for the surgery will aid the development of a three-dimensional image in the surgeon's mind.

This book differs from other books on ESS in that it concentrates on the anatomy and surgical technique. The surgical techniques presented are largely unique but the majority have been scientifically assessed in peer-reviewed journals. The results achieved with each technique are presented. The CD ROM accompanying the text is designed to present a number of examples of different anatomical variations and to allow the viewer to attempt three-dimensional reconstruction of the anatomy before this is shown on the video. The actual operation is then shown in edited form so that the anatomy seen during surgery can be compared to the mental picture generated by the viewer. In addition, videos of all techniques are presented with the aim of reinforcing the surgical steps shown with diagrams in the text. This book and CD ROM focus primarily on surgical technique rather than on the medical aspects of the various diseases, which can be found in other excellent texts currently available.

Acknowledgments

A book of this nature is an accumulation of all knowledge gleaned from many teachers over a number of years. However, I would like to single out Mike McDonogh as the teacher who had the greatest influence on my career as a rhinologist. Mike is an exceptional person who is a great teacher and who is highly innovative. His ideas led to the development of the "swing-door technique" of uncinectomy and the "bath-plug" closure for cerebrospinal fluid leaks. I remain forever indebted to him for his teaching, mentoring, and friendship.

I would also like to thank Simon Robinson for reading the manuscript and making helpful suggestions as to how it could be improved. Thanks to Alan McNab and Nic Vrodos for commenting on the orbital decompression and pituitary surgery chapters.

Andrew van Hasselt deserves special mention for his support over many years. In addition I would like to thank the Australian ENT society members for making me so welcome in Australia and supporting the development of ENT academia.

Peter-John Wormald

Contents

1

Setup and Ergonomics of Endoscopic Sinus Surgery

In the past 17 years there has been a significant shift from external and headlight sinus surgery to endoscopic sinus surgery (ESS). This was initially driven by Messerklinger's work, which showed that the sinuses had a predetermined mucociliary clearance pattern to their natural ostium irrespective of additional openings that may have been created into the sinuses.[1] This philosophy of opening the natural ostium of the diseased sinus was then popularized by Stammberger[2] and Kennedy.[3] ESS is now accepted as the surgical management of choice for chronic sinusitis. In addition, as our knowledge of the anatomy of the sinuses has improved, other ancillary surgeries such as endoscopic lacrimal surgery[4] and orbital decompression[5] have developed. Further development of instruments has led to acceptance of endoscopic management of benign endonasal tumors[6,7] and more recently there are reports of the endoscopic management of malignant tumors[8] of the nose and sinuses. This significant and rapid development of new surgical techniques in ESS could not have occurred without significant instrument development.

Instruments

Table 1–1 presents a full list of ESS instruments used by the author. If several companies manufacture the instrument, no manufacturer is named. If the instrument is only made by one company, then the manufacturer is named. The following are the most important instruments:

- Small rotating backbiting forceps
- Sickle knife
- Small (2.5 mm) straight and 45 degree upturned Blakesley forceps
- Small (2.5 mm) straight and 45 degree upturned through-biting (cutting) Blakesley forceps
- Endoscopic scissors
- Double right-angled ball probe
- 45 and 90 degree giraffe cup forceps, 45 and 90 degree through-biting giraffe forceps
- Hajek Koeffler forward biting punch
- Suction Freer's dissector
- Curettes (straight and 45 and 90 degree)
- Malleable suction Freer's dissector* (Medtronic Xomed, Jacksonville, Florida, USA)
- Malleable suction curette* (Medtronic Xomed)
- Malleable frontal sinus probe* (Medtronic Xomed)

Powered Microdebriders

Powered microdebriders now form an essential part of the instrumentation that is required for ESS. These instruments allow the surgeon to remove blood from the operating field with the blade open and then with considerable precision the tissue can be cut by the rotating inner blade of the microdebrider. This precision cutting of mucosa minimizes the potential for stripping of the mucosa and achieves maximum mucosal preservation. Mucosal preservation should improve the postoperative healing and therefore the results of the surgery. These instruments are very effective at removing tissue and if placed in the wrong area, such as the orbit, can quickly create significant damage to the orbital contents.[9,10] The soft consistency of the orbital fat predisposes it to being

TABLE 1–1 Full List of Operating Instruments

Qty	Instruments
	Jacobson angled 7" needle holder
	6" fine needle holder
	Small Luc forceps
	Angled Heyman turbinectomy scissors
	Tilley Henkel forceps
2	Tilley packing forceps
2	Mosquito curved artery clips
5	Backhaus towel clips
	Sponge holder
	McIndoe forceps
	Adson toothed OR Adson Brown forceps
	Adson plain OR tungsten tip forceps
2	Suture scissors
	Iris curved scissors
	No. 7 scalpel blade handle
	Freer's dissector
	Frazier 9 French gauge sucker and stilette
	Frazier 10 French gauge sucker and stilette
	Dental syringe
	Heath's mallet
	Small Killian's speculum
	Medium Killian's speculum
	Large Killian's speculum
	Sinoscopy Instruments
	Medium straight Blakesley forceps
	Medium upcutting Blakesley forceps
	Blakesley forceps straight through cut
	Blakesley forceps upturned through cut
	Right ostrum punch downcut
	Left ostrum punch downcut
	Sinus short sucker
	Sinus long sucker
	Sickle knife
	Freer's dissector
	Double-ended probe
	Kuhn Bolger frontal ostium seeker
	Kuhn Bolger frontal sinus curette 55 degrees
	Antrum curette
	90 degree curette
	Sucker Freer's and stiletto
	Rotating Microbite Backbiter
	Hajek Koffler sphenoid punch 90 degree upcut forward
	Special Instruments (singles)
	Sinoscopy scissors—straight
	Sinoscopy scissors—curved left
	Sinoscopy scissors—curved right
	Kuhn Bolger giraffe forceps horizontal
	Kuhn Bolger giraffe forceps vertical
	Kuhn Bolger forceps 60 degrees
	Kuhn Bolger forceps 90 degrees
	Kuhn Bolger forceps 90 degrees right angled
	Kuhn Bolger forceps 90 degrees left angled
	Ligature clip carrier
	Wormald Sucker Bipolar
	Wormald's suction bipolar forceps*
	Sterilization case
	Bipolar cable
	Bipolar diathermy 22.2 cm, 0.5 fine tip (upturned)
	Xomed Frontal Trephine Set
	Xomed frontal trephine set
	Drill guide
	Drill pin
	Irrigation cannula (reusable; keep six in stock)
	Sterilizing tray
	Wormald Malleable Sinus Instruments*
	Wormald malleable sinus probe
	Wormald malleable sinus suction
	Wormald malleable sinus elevator blunt
	Wormald malleable sinus elevator sharp
	Sterilization tray
	Wormald Dacryocystorhinostomy Set* Medtronics/Xomed
	Sickle knife
	Spear knife
	Lusk microbite forcep
	Equipment
	Camera System
	STORZ TRICAM SL
	0 degree endoscope (4 × 11 mm Hopkins)
	30 degree endoscope
	45 degree endoscope
	70 degree endoscope
	Lens Washer
	Endoscrub II
	Consumables
	0 degree Endoscrub II sheath
	30 degree Endoscrub sheath
	Microdebrider
	XPS 3000
	Magnum straight shot handpiece II
	Solutions
	Topical
	Cocaine solution (10%—2 mL)
	Adrenaline (1:1000 × 1 mL)
	Normal saline (0.9 × 3 mL)

sucked into the blade opening of the microdebrider where it is cut by the rotating inner blade at a frightening rate. If the surgeon is unaware of having penetrated the orbital periosteum with the microdebrider, significant damage can occur within a few seconds. There are numerous case reports in the literature where powered microdebriders have been used and inadvertent injury to the orbital contents and especially the medial rectus muscle has occurred.[9,10]

The blade is used in oscillate mode for the majority of the surgery. Most of the instruments will have a default setting that will allow the blade to oscillate at 3000 rpm. The foot pedal will also usually have a switch that allows the surgeon to select either variable or full speed when the pedal is depressed. Variable mode allows the surgeon to slow the speed whereas full speed turns the blade at 3000 revolutions immediately upon depression of the pedal. It is important to understand that the speed at which the blade turns determines the amount of tissue that is cut. The higher the speed the less time the blade is open and the less tissue is able to be sucked into the blade before the turning blade cuts the tissue. The slower the speed the more tissue is sucked in and the more aggressively the blade cuts. Figure 1–1A shows the blade in open mode and Figure 1–1B shows tissue being sucked into the lumen of the blade before rotation of the blade cuts the tissue.

In forward and reverse mode the revolutions may vary from 3000 to 15,000 rpm and consequently the blade is open for only a very short time. Cutting in this mode is thus severely limited. Forward mode is usually used for the various burr attachments that can be used in place of the blade.

■ Endoscope Cleaners

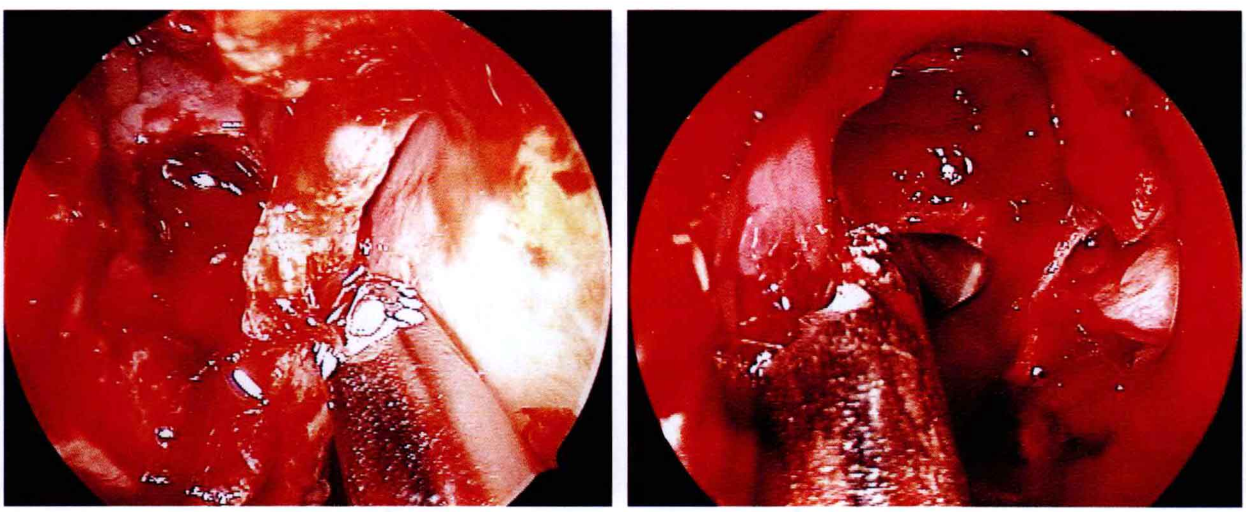
A large number of companies make endoscope cleaners or scrubbers. These are designed to wash the end of the endoscope if it becomes contaminated with blood. If the surgical field is bloody, the endoscope cleaner keeps the scope end clear of blood and allows the operation to proceed without the need to remove the scope from the nose and manually clean it. The endoscope cleaner speeds up the operation, improves the safety of the surgery by maintaining visibility, and decreases the surgeon's frustration level by allowing the surgery to progress.

■ Cameras and Monitors

Surgery can be performed either through the eyepiece of the endoscope (traditional technique) or off the monitor by connecting a camera to the endoscope. The traditional technique (down the endoscope) gives the surgeon a certain degree of orientation and depth perception. However, most surgeons prefer to operate from the video monitor because it allows the surgeon to sit or stand next to the patient and more comfortably view the nasal cavity. This is especially valuable for frontal recess surgery; for an adequate view through the eyepiece, the surgeon's head must lie almost on the patient's chest. In addition, if a large instrument such as the microdebrider is being used at the same time, this instrument may touch the surgeon's head when it is being manipulated in tight spaces. The monitor provides a large magnified image that can be advantageous for delicate precise work (e.g., optic nerve, skull base surgery) and it allows two surgeons to operate together on the patient from the monitor (e.g., pituitary tumor surgery and infratemporal fossa surgery). The other major advantage of operating from the monitor is that it allows for the senior surgeon to monitor the trainee's surgery and allows the trainee (and all in the operating room) to watch the procedure. The nurse can anticipate the surgical instrument required for the next step and the anesthetist can monitor the operating field and perform anesthetic manipulations to improve the surgical field. If the surgeon is operating from the monitor a good quality three-chip camera is required with a powerful light source and medical grade monitor. Single-chip cameras cannot cope with a large amount of blood, and depth perception and tissue contrasts are lost. Visibility and orientation become increasingly difficult for the surgeon and the risk of complications rises.

■ Position of the Patient and the Surgeon

My preference is to sit at the right side of the patient. The surgeon may stand but if the elbow of the operating surgeon is not stabilized the monitor image tends to move erratically, reflecting the instability of the hand holding the endoscope. The patient should be prone and the operating table tilted to 30 degrees head up. The patient's head should be in a neutral position (neither flexed nor extended). This allows the surgeon to operate parallel to the



A B

FIGURE 1–1 (A) The blade is open and (B) tissue is being sucked into the blade prior to rotation of the inner blade severing the tissue.

FIGURE 1–2 The operating setup with the surgeon, the patient's head, and the video monitor all in a straight line. The scrub nurse stands opposite the surgeon, which allows a view of the monitor and facilitates the handing of instruments to the surgeon.

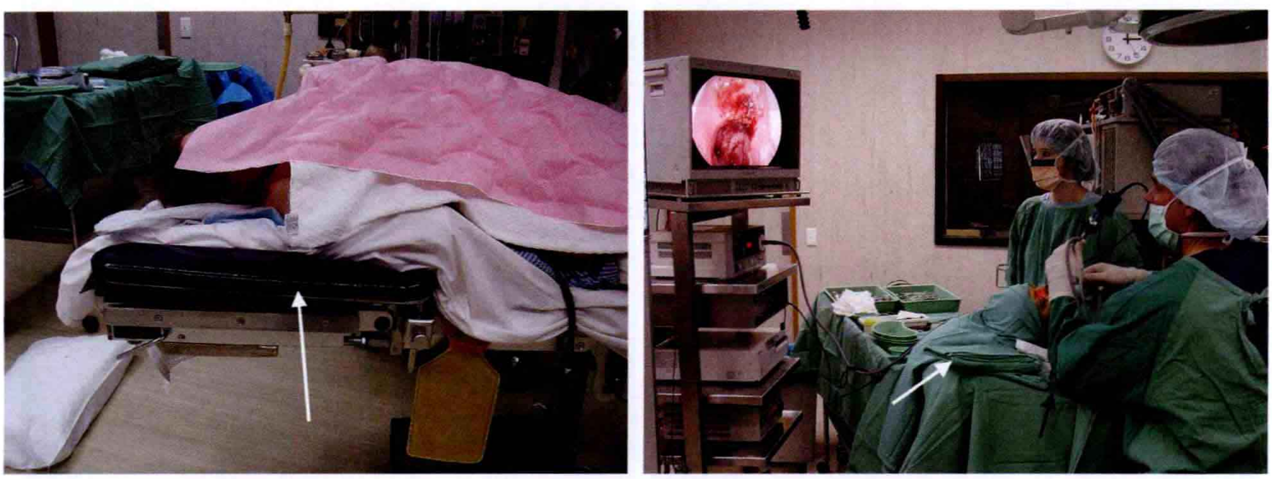
skull base, which diminishes the risk to the skull base by decreasing the angle at which the instruments approach the skull base. The video monitor should be positioned so that the surgeon, the patient's head, and the monitor are in a straight line (Fig. 1–2).

A thin arm board is placed next to the patient's head to enlarge the upper part of the operating table, which allows the surgeon to comfortably rest the elbow. If this position is too low, sterile drapes folded into a square are placed to add height. The patient's head can also be turned toward the surgeon, which decreases the required height for the surgeon's elbow. The scrub nurse's table should be placed so that the far edge of the instrument table is parallel with the head of the operating table. This allows the monitor stack to be placed in a straight line with the patient's head and the surgeon (Fig. 1–3).

■ Principles of Endoscope Placement and Instrument Placement during Endoscopic Sinus Surgery

With the surgeon's elbow resting on the added arm board, the endoscope is slid into the nose. The scope should then be pushed as far superiorly as possible. This should distort the nasal vestibule by placing the scope high in the nasal vestibule. This creates a space in the nasal vestibule below the scope through which all instruments are placed (Fig. 1–4).

The scope and the instruments should never cross during surgery. It is only very rarely when dissecting in the frontal sinus that the scope needs to be placed below an instrument. When this is done the surgeon loses sight of the tip of the instrument and accurate and careful dissection is no longer possible. The zero degree endoscope should be used wherever possible and in the techniques described in the following chapters it is used almost exclusively unless otherwise stated. This simplifies the surgery, decreases the risk of unnecessary damage to adjacent or surrounding mucosa during passage of the instrument, and limits the risk of disorientation that can occur when using angled endoscopes. If angled endoscopes are used, instruments should be curved so that the tip of the instrument can be operated in the center of the endoscope view (see Chap. 7). The greater the angle of the scope the longer the curve needs to be on the instrument. The greater the angle of the scope and curve of the instrument the greater the degree of difficulty with the dissection, so it is best to



A B

FIGURE 1–3 The arm board is placed on the operating table to allow the surgeon to rest the elbow and thus to stabilize the camera. This allows the surgeon's forearm and wrist to be straight, which provides a stable picture on the monitor and is comfortable for the surgeon. The height of the elbow can be adjusted with folded sterile towels as required.

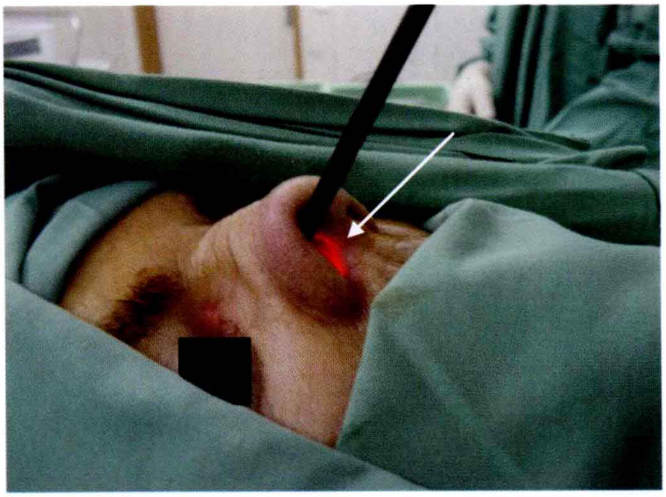


FIGURE 1–4 The scope is used to tent the nasal vestibule superiorly, creating space below the scope (white arrow) through which the instrument is passed into the nose.

avoid using the angled scope (especially the 70 degree scope) during surgery.

Disclaimer

Several instruments presented in this book are manufactured and sold by Medtronic Xomed. Those that are identified by an asterisk (*) have been designed by the author, and a royalty is received from the sale of these instruments. There are no undeclared financial incentives in any of the instruments discussed that do not bear the identifying asterisk.

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2

The Surgical Field in Endoscopic Sinus Surgery

The presence of significant bleeding in the surgical field is a critical factor in the potential success or failure of endoscopic sinus surgery (ESS).[1-4] When significant bleeding is present, discrimination of the anatomy becomes difficult.[2-4] Bleeding obscures surgical planes and makes identification of the drainage pathways of the sinuses difficult. Cell walls become difficult to distinguish from lamina papyracea or skull base, and the risk of causing a complication increases.[3,4] If the patient has significant inflammation of the sinuses from chronic infection or the presence of pus or fungal debris, increased vascularity will often contribute to more bleeding.[2,5] If the surgeon has to manipulate an instrument in the surgical field after the discernible anatomy is covered in blood, the risk of a complication increases. In addition greater surgical trauma may occur, cells may be left behind, and postoperative scarring and failure of the surgical procedure may ensue. It is therefore critical to optimize the surgical field and thereby facilitate the surgical dissection.[2-4]

Our department has a special interest in this aspect of ESS and has conducted several double-blind, randomized, controlled studies in an attempt to establish which maneuvers are worthwhile. To date not all maneuvers have been scientifically evaluated but where there is evidence for a specific maneuver this will be provided. The first important issue to address is a grading system for bleeding in the surgical field. Boezaart et al described and validated a grading system of five grades presented in Table 2–1.[3]

Although this grading system is valuable we have found that the majority of surgical fields are around grade 3 with some grade 2 and some grade 4.[2] Only on rare occasions are grades 1 and 5 seen. This tends to compress the grading system and makes differentiation of more subtle changes difficult. Grade 3 may need to be further subdivided to allow variations within grade 3 to be discerned.[2]

■ Local versus General Anesthetic

Local anesthetic has the advantage of not inducing a generalized vasodilatation. Increased circulating catecholamines may also improve the surgical field by continuing to act on the prearteriolar sphincters and precapillary sphincters. However, there are several limitations associated with local anesthetic:

- Patient anxiety and sudden patient movement during delicate surgery can be problematic.
- Surgery takes between 1 and 2 hours. Some patients (especially older patients) have difficulty remaining still for this length of time.
- Appropriate anesthesia needs to be achieved in all the sinuses and the nasal cavity.
- If the procedure is bloody the patient may have difficulty dealing with the volume of blood trickling into the pharynx. If the patient is sedated aspiration can occur.
- Water from the scope scrubber may add to the secretions in the pharynx that the patient needs to deal with.
- Teaching of residents can be more difficult when the patient is awake.

In our department local anesthetic is offered to patients having limited ESS usually confined to the middle meatus. We prefer general anesthesia for ESS that involves the frontal recess, posterior ethmoids, or sphenoids.

TABLE 2–1 Grading System for Bleeding in the Surgical Field

Grades	*Surgical Field*
Grade 1	Cadaveric conditions with minimal suction required
Grade 2	Minimal bleeding with infrequent suction required
Grade 3	Brisk bleeding with frequent suction required
Grade 4	Bleeding covers surgical field after removal of suction before surgical instrument can perform maneuver
Grade 5	Uncontrolled bleeding. Bleeding out of nostril on removal of suction

Data from Boezaart AP, van der Merwe J, Coetzee A. Comparison of sodium nitroprusside- and esmolol-induced controlled hypotension for functional endoscopic sinus surgery. Can J Anaesth 1995;42:373–376.

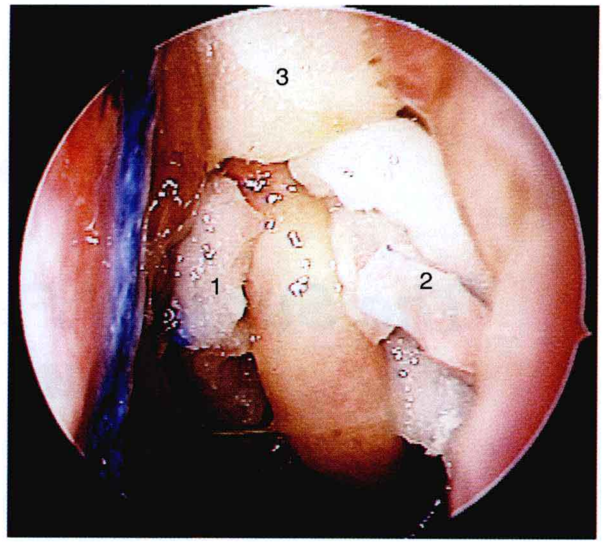

FIGURE 2–1 Placement of the neuropatties in the left nasal cavity prior to surgery. Number 1 neuropatty is in the sphenoethmoidal recess, 2 is in the middle meatus, and 3 is in the region of the axillary flap.

Standard Nasal Preparation for Endoscopic Sinus Surgery

Positioning the Patient

Chapter 1 described positioning of the patient. It is important to have the patient 30 to 40 degrees head up so that the venous return from the head and neck is facilitated. This puts the patient's head above the chest, which lowers the arterial pressure and prevents venous congestion and thereby improves the surgical field.[6]

Topical Vasoconstriction

In a study recently published we showed that any packing material placed in the nasal cavity does cause some damage to the nasal mucosa.[7] The more abrasive the packing, the worse the trauma.[6] The least abrasive and therefore recommended packing material is neurosurgical cottonoid patties. The anesthetist is consulted to ensure there is no contraindication to the use of cocaine. If there is a concern then 1% oxymetazoline is used in place of cocaine. In an adult patient a mixture of 2 mL of 10% cocaine, 1 mL of 1:1000 adrenaline, and 4 mL of saline is divided, with half used to soak six neuropatties. These six neuropatties are placed in the nose after the patient is anesthetized. The other half of the cocaine mixture and remaining four neuropatties are kept sterile on the instrument trolley for later use during surgery as needed. Three neuropatties are placed on each side directly after intubation using a Freer's dissector to manipulate them gently into place. The first neuropatty is placed in the sphenoethmoidal recess, the second under the middle turbinate, and the third over the axilla of the middle turbinate (Fig. 2–1). If there is a concha bullosa or significantly lateralized middle turbinate, the neuropatty is placed along the inferior margin of the middle turbinate. No force is used to place the patties in the middle meatus.

Because only half the solution is used at the beginning of surgery the total dose of cocaine that the patient is exposed to is ~ 100 mg. The toxic dose of cocaine is 3 mg/kg without the simultaneous use of adrenaline. It has also been shown that the presence of adrenaline inhibits mucosal absorption and that a proportion of the solution will remain in the neuropatty. This decreases the amount of cocaine that the patient is exposed to.

Local Infiltration

A 2% solution of lidocaine (lignocaine in the United Kingdom and Australia) with either 1:80,000 or 1:100,000 with adrenalin is used with a dental syringe and needle. The injections are given after the patient has been draped and the camera and endoscope are available. Under endscopic guidance the area above the middle turbinate is infiltrated. This is followed by infiltration into the anterior end of the middle turbinate. Note that the area anterior to the uncinate is not infiltrated because bleeding from an injection site can obscure the uncinectomy procedure. The third injection is into the region of the sphenopalatine artery and is given with a spinal needle because the dental needle is usually not long enough to reach this area. The needle is introduced into the posterior end of the middle turbinate and directed superiorly before infiltration is commenced. Figure 2–2 illustrates the routine infiltration points used.

Preoperative Antibiotics and Steroids

Inflammation increases the vascularity of the tissues, and when surgery is conducted on highly inflamed tissues increased bleeding results. Patients with acute sinusitis who have a complication requiring surgery will usually have a very bloody surgical field. It therefore stands to reason that using antibiotics in patients with a significant infection preopera-