Operative Techniques in Otolaryngology (2011) 22, 200-205

Operative Techniques in

Otolaryngology

Perioperative adjuncts in endoscopic skull base surgery

Abtin Tabaee, MD

From the Department of Otolaryngology, Beth Israel Medical Center, New York, New York.

KEYWORDS
Endoscopic skull base surgery;
Image guidance;
Stereotactic surgery;
Fluorescein;
Lumbar drain;
Pituitary surgery

The field of endoscopic skull base surgery has rapidly evolved in the past decade and is now an accepted treatment modality for a variety of pathologies in the sinonasal cavities and anterior skull base. Inherent to the development of the field are a variety of technologies and surgical adjuncts that are utilized during various aspects of the surgeries. Understanding the indications, utility and limitations of these adjuncts is critical to the endoscopic skull base surgeon. Additionally important is a discussion of the process with which new surgical devices are integrated into clinical practice. The current article discusses this process in general terms and explores the role of stereotactic navigation, fluorescein, powered instrumentation and lumbar drainage in endoscopic skull base surgery.

A vast and continually expanding array of perioperative adjuncts is available to the endoscopic skull base surgeon. To understand the role of each individual device or technique, a systematic discussion is needed to define its indication for use, therapeutic and diagnostic benefits, cost, limitations, and complications. Given the rapidly evolving nature of both the procedures themselves and the associated technologies, continual re-evaluation of these issues becomes necessary. A clear definition of the utility of the various adjuncts is further complicated by the variability in the surgical needs of the different pathologies and anatomic locations in endoscopic skull base surgery. Finally, individual surgeon preferences without objective, substantiating evidence may spur the use of one technology over another. The following article presents a general framework for evaluation of these technologies and a discussion of some of the specific adjuncts in skull base surgery, including stereotactic neuronavigation, intrathecal fluorescein, powered instrumentation, and lumbar drain (LD).

General concepts

The criteria used to evaluate surgical adjuncts include ease of use, cost, availability, risks, and, most importantly, impact on procedure-related outcomes. This analysis is individualized on the basis of both the needs of the procedure and preferences of the surgeon. For a surgical adjunct to endure in the marketplace, beneficial qualities are necessary in some if not all the aforementioned factors. Inevitably, refinements in the existing technology or major developments in new technology allow for continued advancement. In the most basic sense, a surgical adjunct addresses an aspect of the procedure that is not managed ideally by the core instrumentation. In endoscopic skull base surgery, several of these issues exist including visualization, spatial orientation, hemostasis, tissue removal, tissue protection, and tissue repair.

The process of technology or technique development can be divided into the following phases: identification of the problem, evaluation of the currently available solutions (including deficiencies), creation of a new technology or technique, preclinical research and development, limited clinical use with ardent data acquisition, and finally widespread marketplace availability. Continual refinements are made throughout the process, and the technique or technology may not be realized in its mature form for a significant period. This process typically involves collaboration between clinicians and biomedical industry, especially for new instrumentation.

Ultimately, the success of the technique or technology must be made on the basis of clinical measures. These measures vary from informal and highly subjective, as in

---

Address reprint requests and correspondence: Abtin Tabaee, MD, Department of Otolaryngology, Beth Israel Medical Center, 10 Union Square East, Suite 4J, New York, NY 10003.
E-mail address: atabaee@hotmail.com.

1043-1810/$ -see front matter © 2011 Elsevier Inc. All rights reserved.
doi:10.1016/j.otot.2011.08.007

surgeon preference or anecdotal experience, to highly robust and critical, as in randomized, controlled outcomes studies. Unfortunately, most of the surgical adjuncts used in endoscopic skull base surgery do not lend themselves easily to controlled, randomized studies. The limiting issues related to study design include the heterogeneity of the pathologies and surgeries, the multifaceted aspects of the surgery, the impracticality and cost associated with large studies, and the large patient volume needed to achieve statistical power. As a result, research in which authors investigate the available surgical adjuncts remains limited. This lack of supportive research, however, does not diminish the importance of these technologies or techniques. Their ongoing development is a critical aspect of the continued advancement of endoscopic skull base surgery.

Stereotactic neuronavigation

Modern endoscopic visualization systems afford a magnified, high-resolution, and panoramic view of the sinonasal and intracranial cavities. However, several limitations currently exist with this modality of visualization, notably the projection of a 3-dimensional field on a 2-dimensional screen, the cavitary nature of the dissection, and finally the separation of structures by soft-tissue and bony boundaries that may not allow for anatomic orientation until they have been transgressed. These issues, when combined, may result in lack of depth perception and anatomic disorientation. Stereotactic neuronavigation, or image guidance as it is commonly known, provides additional anatomic information that complements the endoscopic view and may increase the surgeons' understanding of the operative field. The technology has been extensively applied to endoscopic sinus surgery, intracranial neurosurgery, and endoscopic skull base surgery. Reproducible accuracy to within 2 mm has been demonstrated.[1,2]

There are many forms of image guidance−type technology each with distinct features. Most of the clinical experience to date involves intraoperative navigation based on a triplanar view of preoperative radiographic studies. This process involves the patient undergoing a preoperative imaging study that is formatted for use by the navigation system, typically with data slices of 1-mm thickness. The data are then uploaded onto the computer workstation and reviewed preoperatively by the surgical team. The currently available image guidance software allows for sophisticated manipulation of the image guidance data set, including creating 3-dimensional models, and toggling through different radiographic and virtual representations of the surgical trajectory.

After the induction of anesthesia in the patient, the registration is performed, which allows a direct 3-dimensional correlation of the surgical anatomy with the uploaded radiographic studies. This is a critical step in the use of navigation technology and has been traditionally a common cause of inaccuracy. A number of different modes of registration exist, including externally applied fiducial markers, disposable headsets or headbands, rigid fixation in pins with attachment of the reference array to the head frame, and direct placement of the reference array directly into the skull.

During the course of the procedure, the registration accuracy may degrade, and a repeat registration may be indicated. After registration, calibration of the instruments that will be used for navigation is performed. A number of different surgical instruments are available for tracking, including probes, suctions, dissection instruments, and powered devices. Some of the current navigation technologies allow for navigation with any traditional surgical instrument. Surgical tracking is performed during the course of the surgery on the basis of the surgeon's discretion, typically to confirm or query the location of a critical area and to gain a global perspective of the surgical field. Surgical tracking is executed differently by the different manufacturers and is typically determined by infrared technology or electromagnetic technology, each with distinct advantages and drawbacks. Notably, the infrared technology requires direct line of site, which may be awkward in certain situations. Conversely, the potential for metallic interference exists with the electromagnetic technology.

Image guidance surgery may be justifiably used, at the discretion of the surgical team, in nearly all endoscopic skull base procedures. Most of the surgeon's endoscopic orientation is determined by skill, experience, and the preoperative imaging studies. Image guidance is a useful complement but not a substitute for these factors. During the approach and resection portions of the procedure, the navigation allows for surgical orientation of the sinonasal structures that are being transgressed, for delineation of the boundaries of the tumor and for identification of the surrounding neurovascular structures. In routine procedures, the additional information conveyed by neuronavigation may be minimally useful. The greatest benefit relates to patients with complex anatomy, revision surgery, or extended procedures.[3,4]

A number of different image guidance modalities exist on the basis of the radiographic information provided, each with relative benefits and limitations. computed tomography (CT)-based studies provided excellent bony anatomy but limited soft tissue detail. CT-based studies may be ideal in patients with complex sinonasal pathology and where the complexity of the surgical approach or the tumor itself is bony. Conversely, magnetic resonance image (MRI)-based studies provide excellent soft tissue but limited bony detail. MRI is ideal in patients with soft-tissue tumors and noncomplex sinonasal anatomy (Figure 1). Inclusion of intravenous contrast at the time of data acquisition for either modality allows for improved vascular delineation. "Fusion" technology refers to the merging of both CT and MRI data for navigation. This integrates the benefits of bony and soft tissue detail associated with CT and MRI, respectively.

The primary limitation of neuronavigation on the basis of preoperative studies is the failure of the dataset to reflect intraoperative changes. This issue is minimal for the sino-