

# Contents

## **Preface**

**xi**

Michael E. Sughrue and Charles Teo

## **The Concept of Minimally Invasive Neurosurgery**

**583**

Charles Teo

Applying the concept of keyhole techniques to neurosurgery has divided the neurosurgical community. This should never have happened because keyhole refers to a philosophy not a size. This philosophy stems from a desire to minimize collateral damage without compromising the intended goal of surgery. The revolution received its impetus from technological advances in pre- and intraoperative navigation, use of surgical-friendly anesthetic agents, lower profile instruments, the introduction of hemostatic agents, and better visualization. If a smaller craniotomy compromises the goal of surgery, then the approach should be re-evaluated and modified to achieve minimal collateral damage and maximal efficacy.

## **Application of Technology for Minimally Invasive Neurosurgery**

**585**

Masaru Ishii and Gary L. Gallia

Minimally invasive neurosurgery has developed from technological innovations, including endoscopy, instrumentation, neuroimaging, stereotaxy, and others. This article highlights current technologies for minimally invasive cranial neurosurgery.

## **Transcranial Minimally Invasive Neurosurgery for Tumors**

**595**

Mark Garrett, Giacomo Consiglieri, and Peter Nakaji

This article considers common minimally invasive craniotomy approaches and the role of neuroendoscopy in the removal of extra-axial and intra-axial brain tumors, excluding those of the ventricle. The use of a keyhole craniotomy combined with a carefully selected trajectory can help avoid the disadvantages associated with a standard craniotomy. However, the decision to use endoscopy must be individualized based on the patient and tumor. Endoscopy can also be used as a surgical adjunct to improve tumor resection and to help protect neurovascular structures. Complications associated with minimally invasive tumor neurosurgery have been similar to those associated with conventional neurosurgical approaches, and available outcomes are promising.

## **Minimally Invasive Surgery (Endonasal) for Anterior Fossa and Sellar Tumors**

**607**

Timothy Lindley, Jeremy D.W. Greenlee, and Charles Teo

The primary goal of any surgical approach is to adequately visualize and treat the pathologic condition with minimal disruption to adjacent normal anatomy. The work of several researchers has revealed the promise of minimally invasive endonasal neurosurgery and paved the way for broader applications of the technology. This article discusses the current state of minimally invasive endonasal techniques to address the pathologic conditions of the anterior cranial fossa and parasellar region.

**Expanded Endonasal Approaches to Middle Cranial Fossa and Posterior Fossa Tumors****621**

Daniel M. Prevedello, Leo F.S. Ditzel Filho, Domenico Solari, Ricardo L. Carrau, and Amin B. Kassam

Skull base lesions that involve the middle and posterior cerebral fossae have been historically managed through extensive transcranial approaches. The development of endoscopic endonasal techniques during the past decade has made possible a vast array of alternative routes to the ventral skull base, providing the ability to expose lesions in difficult-to-access regions of the cranial base in a less invasive manner. In this review, the authors detail the endoscopic surgical anatomy and the operative nuances of the expanded endoscopic endonasal approaches to tumors of the middle and posterior cranial fossae. These techniques offer excellent exposure of the targeted regions yielding optimal resections, while avoiding the morbidity associated with transcranial surgical approaches.

**Reconstruction of Dural Defects of the Endonasal Skull Base****637**

Michael E. Sughrue and Manish K. Aghi

Endonasal, endoscopic approaches to the cranial base have undergone significant technique refinement over the past decade. Repair of the resultant defects remains perhaps the most important concern with these approaches; however, recent advances suggest that with careful attention to the closure, these procedures can be done with acceptable rates of morbidity. In this review, the authors discuss known techniques for the repair of endonasal defects, and provide some insight based on their experience.

**Making the Transition from Microsurgery to Endoscopic Trans-Sphenoidal Pituitary Neurosurgery****643**

Isaac Yang, Marilene B. Wang, and Marvin Bergsneider

This article reviews the published experience of others and introduces the authors' insights into the development of an endoscopic pituitary program. While initially challenging, this transition to endoscopic trans-sphenoidal pituitary surgery can yield rewards in the form of superior visualization and potentially more complete tumor resections. With increasing cumulative experience with the endoscopic transsphenoidal technique for pituitary surgery, the improved visualization and less steep learning curve will facilitate more widespread acceptance of endoscopic pituitary surgery as a valid alternative to the trans-septal trans-sphenoidal microscopic approach to pituitary tumors. If not a complete alternative, endoscopic-assisted pituitary surgery will also become more widespread, as endoscopy can easily supplement standard microscopic approaches to pituitary tumors. As transnasal endoscopic approaches to the skull base are increasingly refined in technology and skill, additional applications of this technology may permit skull base approaches through the planum sphenoidale and tuberculum sellae for the removal of giant suprasellar macroadenomas that may otherwise require an open craniotomy for surgical management. The collaboration between otolaryngologists and neurosurgeons is important for further developing successful endoscopic trans-sphenoidal pituitary surgery and improving care for patients. Objective evidence is needed to validate whether the improved visualization results in superior patient outcomes and reduced clinical complications, and if this technique can be reasonably taught in a controlled, supervised setting in residency training programs. Additional outcomes data are needed to evaluate long-term outcomes and define the boundaries of endoscopic trans-sphenoidal pituitary surgery.

**Minimally Invasive Neurosurgery for Cerebrospinal Fluid Disorders****653**

Daniel J. Guillaume

This article focuses on minimally invasive approaches used to address disorders of cerebrospinal fluid (CSF) circulation. The author covers the primary CSF disorders that are amenable to minimally invasive treatment, including aqueductal stenosis, fourth ventricular outlet obstruction (including Chiari malformation), isolated lateral ventricle, isolated fourth ventricle, multiloculated hydrocephalus, arachnoid cysts, and tumors that block CSF flow. General approaches to evaluating disorders of CSF circulation, including detailed imaging studies, are discussed. Approaches to minimally invasive management of such disorders are described in general, and for each specific entity. For each procedure, indications, surgical technique, and known outcomes are detailed. Specific complications as well as strategies for their avoidance and management are addressed. Lastly, future directions and the need for structured outcome studies are discussed.

**Minimally Invasive Neurosurgery for Vascular Lesions****673**

Nikolai J. Hopf and Lars Füllbier

Intracranial vascular lesions are known to affect 2% to 4% of the population, predisposing those affected to a lifetime risk of hemorrhagic stroke, ischemia, focal neurologic deficits, or epileptic seizures. These lesions constitute a heterogeneous group, with different lesion types characterized by distinct biologic mechanisms of pathogenesis and progression. In this article, the minimally invasive management of intracranial aneurysms, arteriovenous malformations including arteriovenous fistulas, and cavernous malformations are discussed.

**Minimally Invasive Surgery for Movement Disorders****691**

Paul S. Larson

Movement disorders surgery, particularly deep brain stimulation (DBS), is already a minimally invasive procedure. However, new innovations in the delivery devices for DBS electrodes, new methods for target localization, and alternatives to implanted hardware are all strategies that can make movement disorders surgery less invasive. Frameless DBS techniques can increase patient comfort and shorten operative time. Interventional magnetic resonance imaging can further reduce operative time, and allows DBS placement to be done with a patient asleep and usually with a single brain penetration. Finally, gene transfer eliminates the need for implanted hardware or batteries and simplifies postoperative care.

**Complication Avoidance in Minimally Invasive Neurosurgery****699**

Michael E. Sughrue, Steven A. Mills, and Ronald L. Young II

Although minimally invasive neurosurgery (MIN) holds the potential for reducing the approach-related impact on normal brain, bone, and soft tissues, which must be manipulated in more conventional transcranial microneurosurgery, the techniques necessary to perform minimally invasive, yet maximally effective neurosurgery place significant demands on the surgeon because in many ways the more limited exposure creates a number of unique ways these operations can go wrong. Safe and effective MIN requires the conscious institution of specific alterations to the surgeon's usual operative case flow, which are designed to make specific well-known mistakes impossible or at least very unlikely. Thus, it is important for the aspiring MIN surgeons to learn from the mistakes of their predecessors and to institute patterns of

behavior that prevent a repetition of these mistakes. This article provides practical information regarding known pitfalls in intraventricular and transcranial neuroendoscopic surgeries and practical methods to reduce the incidence of these complications to the lowest rate possible.