Skullbase Surgery: Open vs. Endoscopic

Prof. Asim Mahmood, FRCS, FACS, FICS, FAANS,
Professor of Neurosurgery
Henry Ford Hospital
Detroit, MI, USA

Skullbase Lesions

- Anterior Cranial Fossa
  - Subfrontal meningioma
  - Olfactory neuroblastoma
  - CSF leaks
- Middle Cranial Fossa
  - Petrosal adenomas and cysts
  - Suprasellar meningioma
  - Cavernous sinus meningioma
- Posterior Cranial Fossa
  - Acoustic neuroma
  - Petroclival meningioma
  - Petroclival cysts
  - Cholesteatoma
  - Cholesterol granuloma
  - Chordoma

Choice Of Surgical Approaches

1980 Standard microsurgical approaches
- Subfrontal/pterional
- Transcallosal
- Transventricular
- Transsphenoidal

1990 Skull base approaches
- Fronto-orbital
- Extended frontal
- Orbitozygomatic
- Extended transsphenoidal

2000 Minimally invasive approaches
- Transventricular
- Supraorbital glabellar
- Transsphenoidal

Skullbase Surgery: Evolution

1980 “Old school”
- Relatively conservative with gross total resection attempted but often not achieved and followed with observation or adjunctive therapies

1990 “Maximally invasive” approaches
- Frequent attempts at radical resection of the tumor with surgical approaches designed to maximize bony removal in order to minimize brain retraction

2000 “Minimally invasive” approaches
- Limited bony removal and microsurgical tumor removal
  - Endoscopic skullbase surgery
Olfactory Meningioma

Background
- Clinical presentation: seizure, headache
- Slow-growing lesions that are curable with complete resection of tumor and involved dura
- Recurrence after subtotal resection managed with radiation therapy

1985 Bifrontal craniotomy
1995 Extended Frontal craniotomy
2004 Unilateral craniotomy vs Extended Endonasal

Olfactory Neuroblastoma

Background
- clinical presentation: headache, epistaxis, CSF leak, nasal obstruction
- relatively rare lesion originating from olfactory neuroepithelium in upper nasal cavity
- low- and high-grade tumors with 5-year survival rates of 75-100% and 0-44%, respectively, depending on clinical grade
- no systematic clinical trials

1985 Craniofacial resection
1986 Craniofacial resection
2000 Craniotomy and Endoscopic resection
Pituitary Lesions

Background
- clinical presentation: headache, visual loss, hormonal syndromes (Cushing’s disease, acromegaly, amenorrhea)
- slow-growing tumors with low recurrence rates (<10%)
- adenomas, Rathke’s cysts, arachnoid cysts

1980 Craniotomy
1985 Microscopic Transsphenoidal
- dopamine agonists
1995 Microscopic vs Endoscopic
2000 Endoscopic vs unilateral direct transsphenoidal

Pituitary gland and Parasellar region

Standard Transsphenoidal

Pituitary adenoma
**Standard Microscopic transsphenoidal approach**

**Rathke’s Cyst**

**Background**
- clinical presentation: visual loss, headache
- uncommon lesions with high recurrence rates after simple transsphenoidal drainage

1980 Craniotomy
1990 Transsphenoidal
2000 Transtubercular transsphenoidal

**Angles of View**
- transnasal
- standard sublabial
- sublabial transtubercular
CSF Leaks

Background
- clinical presentation; rhinorrhea, meningitis
- post-traumatic, post-operative (iatrogenic), congenital

1985 Craniotomy
1995 Endoscopic repair
2000 Endoscopic repair

Craniopharyngioma

Background
- clinical presentation as visual loss (peripheral vision)

1985 Craniotomy for resection
1995 Craniotomy for resection
2005 Microscopic transtubercular transsphenoidal vs pure endoscopic

Suprasellar meningioma
Suprasellar meningioma

1985 Middle fossa craniotomy
1990 transtemporal marsupialization
2003 transsphenoidal microscopic vs endoscopic

Petrous apex cysts

Background
- clinical presentation: headache, recurrent ear infections, double vision
- very slow-growing and are composed of squamous epithelium

1985 Middle fossa craniotomy
1990 transtemporal marsupialization
2003 transsphenoidal microscopic vs endoscopic

Petrous Apex Cyst
Petrosus apex cyst

Transsphenoidal route to cyst

Microscopically or Endoscopically
<table>
<thead>
<tr>
<th><strong>Clival Tumors</strong></th>
<th><strong>Clival Chordoma</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chordoma</strong></td>
<td><img src="image" alt="Clival Chordoma" /></td>
</tr>
<tr>
<td>1985 craniotomy</td>
<td></td>
</tr>
<tr>
<td>1995 staged craniotomies</td>
<td></td>
</tr>
<tr>
<td>2005 limited craniotomy vs endoscopic resection</td>
<td></td>
</tr>
<tr>
<td><strong>Petroclival Meningioma</strong></td>
<td></td>
</tr>
<tr>
<td>1985 Craniotomy and radiation therapy</td>
<td></td>
</tr>
<tr>
<td>1995 Transpetrous craniotomy</td>
<td></td>
</tr>
<tr>
<td>2005 Observation vs Transpetrous craniotomy and radiosurgery vs Radiosurgery alone</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of brain areas](image)
Endoscopic Endonasal Surgery

Why go to the endoscope

1. morbidity of open approaches
2. how often is tumor actually not completely removed with larger approaches?
3. approach skullbase lesions from a ventral anterior route thereby avoiding brain structures.

Frontal Skullbase lesions: transition

- Craniootomy although still the preferred approach to most, especially large, frontal tumors carries defined risks.
- The absolute need for radical resection is controversial in many benign lesions and often not achievable in malignant lesions without unacceptable morbidity.
- Transnasal approaches theoretically may limit to risks to intracranial structures.
- The evolution of endoscopic techniques are leading to more minimally invasive means for dealing with lesions.
- The learning curve is steep and morbidities and outcomes are only recently being determined.
Endoscopic Endonasal Surgery: Common lesions

- Pituitary adenoma
- Craniopharyngioma
- CSF leaks
- Frontal cranial base meningiomas
- Petrous apex cysts

Endoscopic Endonasal Surgery

History

Early 1900s - Halsted uses transnasal corridor to access the pituitary gland
- Cushing popularized transphenoidal approach
- Wide surgical corridor critical for manipulation of instruments and head-mounted lighting

Mid 1900s - The sublabial dissection was eliminated giving way to simple transnasal transeptal transphenoidal approach; even less room for light

1970 - Hardy uses the microscope for transphenoidal surgery

1980 - Kennedy pioneered rod lens lighting for sinonasal surgery leading to the endoscopic ability to deliver bright light in a narrow surgical corridor

1990 - Early applications for endoscopic surgery for pituitary lesions were pioneered by Jho and Carrau

Endoscopic Endonasal Surgery

The modern surgical approaches have followed developments in four critical elements: surgical corridor, visualization tool, instrumentation and reconstructive needs

Integration of two-dimensional endoscopic images into a three-dimensional model were facilitated by computerized navigational systems

Newly designed instrumentation was able to overcome technical limitations

A significant obstacle to progress was the lack of neurosurgeons’ experience with endoscopes along with concerns about the ability to deal with hemorrhage and reconstructions of large cranial base skull defects

Endoscopic Endonasal Surgery

Patient selection
- Inflammatory sinus disease treated prior
- Tumor size not a limiting factor for experienced surgeons
- Malignant lesions requiring wide margins and facial resections are best treated in standard manner
- Contraindications;
  - Resection of major vessel
  - Target is deep to a major neurovascular structure
  - The tumor involves superficial tissues

Endoscopic Endonasal Surgery
Endoscopic Endonasal Surgery

Outcomes in 800 patients at University of Pittsburg: Kassam, Carrau and Snyderman et al J Neurosurgery 114, 1545, 2011

- 6.0% CSF leaks
- 2.5% Transient neurological deficit (20 patients)
- 1.8% Permanent neurological deficit
- 1.6% Intracranial infection
- 0.9% Mortality

Conclusions

Although intracranial combined with extracranial approaches remain the mainstay for many skullbase lesions, endoscopic endonasal approaches are becoming a more common and effective alternative in selected cases.