Progress in Brain Tumor Surgery

Then (1911)  

Today (2015)
Surgical Removal

Common challenges

• Where is the tumor located?
• What is the best / safest path to the tumor?
• When is the tumor removed?
• How to safely remove tumor?

Tools

• Microscope
• Endoscope (minimally invasive)
• Image-guided surgery (GPS for surgeons)
• Functional MRI
Lighting and Magnification

• Microscope light
  • May be difficult to see around tissue
  • Need to retract brain for light

• Endoscopy light
  • Scopes are 2-4 mm diameter
  • Light at end of instrument
Minimally Invasive (Keyhole) Concept

- Minimize craniotomy and optimize location
  - Reduced trauma
  - Better healing
  - At least equal effectiveness to remove lesions when compared to “standard” approaches
- Improved lighting: used with microscope, endoscope, or both
Craniotomy = bone opening cut in skull

- **Standard craniotomy** - window cut into the skull; bone flap is replaced and secured with plates
- **Minimally invasive (keyhole)** – small hole, minimal brain retraction; may use endoscope
- **Skull base** - complex holes that remove bone from the bottom of the skull; may require reconstruction of the bony defect
Planning is Everything
Minimally Invasive Approaches

- Transnasal (nose)
- Transorbital (eyelid)
- Supraorbital (eyebrow)
- Mini pterional (temple)
- Retromastoid (behind ear)
Planning for Minimally Invasive

- Preoperative imaging
- Stereotactic guidance
- Positioning
- Brain relaxation
- Hair and scalp preparation
Image-guided surgery (IGS)

- **Step 1.** MRI or CT scan
- **Step 2.** Computer builds a 3D model from patients’ scans
- **Step 3.** Computer model and patient are registered to each other in OR
- **Step 4.** Surgeon operates and views his instruments on 3D map of the patient
Image-guided surgery - Mapping

Advances

• Combine different imaging modalities in 1 view
  • Arteries
  • Veins
  • Tumor
  • Functional areas
Functional MRI & Diffusion Tensor Imaging (DTI)

- **Functional MRI**
  - Detects changes in blood oxygen when brain areas perform a specific task
  - Speaking, story listening, moving arms & legs

- **Diffusion Tensor Imaging**
  - Detects water movement along the connection fibers between brain areas

![Brain MRI with labeled areas](image)
Functional MRI (fMRI) and Diffusion Tensor Imaging (DTI)

- Allow localization of functional areas of the brain
- New techniques allow data to be incorporated into image guided surgery
- Navigation not only to tumor but around functional areas
Minimally Invasive Neurosurgery
(Endoscopy)
Cranial Endoscopy
(minimally invasive neurosurgery)
Patient setup

- CT / MRI image guidance
- Endoscopy - 4-handed approach
Tumor removal

- Dissect dura from tumor
- Develop tumor margin by blunt dissection
- Lateral dissection along cavernous sinus
- Posterior dissection from pituitary stalk
Radiation Treatment (internal)

- Brachytherapy
  - I-125 seeds
  - High dose to tumor
  - Low dose to brain
Radiation Treatment (internal)

Pre-op

Seeds in situ

Dosimetry
Chemotherapy

- Wafers soaked in chemotherapy drug are placed into tumor bed after tumor is surgically removed
BRAIN TUMOR SURGERY

FUTURE
FUTURE – Robotic Surgery
FUTURE - Advances in Imaging

Molecular Imaging in OR
- Mass spectrometry
- Optical imaging
- Molecular ultrasound
- Nanoparticle imaging
FUTURE – Intraoperative Molecular Imaging

- 5-ALA (aminolevulinic acid) taken up by malignant glioma and converted to fluorescing molecules that can be seen with a microscope using special filters