Clinical Aspects of Brain Tumours

Master of Science in Neurological Sciences
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Neurosurgery
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Classification of Brain Tumors

- **Primary**
  - Benign: Meningioma 20%
  - Malignant: Glioma 30%

- **Secondary (30%)**
  - Commonest tumors in the brain
  - Lung / Breast / Skin
  - Colorectal / Kidney / Prostate / Gonadal
  - Unknown Primary (15% of all brain 2')

Neoplastic

- **Primary**
  - Glioma
  - Meningioma
  - Neuroma
  - Others

- **Secondary**
  - Metastasis
Neoplastic

- Primary
  - Glioma
  - Meningioma
  - Neuroma
  - Others
- Secondary
  - Metastasis

Primary Brain Tumors

- Neuroectodermal
  - Glial cells
  - Astrocytoma
  - Oligodendroglioma
  - Ependymoma
  - Medulloblastoma
- Mesenchymal
  - Meningioma
  - Haemangioblastoma
  - Sarcoma
- Lymphoid
  - Lymphoma
- Nerve Sheath
  - Acoustic neuroma
  - Trigeminal neuroma
- Germ Cell Tumor
  - Germinoma
  - NG-GCT

Classification of Brain Tumors

- Supratentorial
  - Metastasis, glioma, meningioma
- Infratentorial
  - Metastasis, glioma(ependymoma, medulloblastoma), meningioma, haemangioblastoma
- Specific locations
  - Pituitary / Sellar
  - Pineal
  - Cerebellar-pontine angle

Symptoms & Signs

- Raised intracranial pressure (ICP)
  - Headache / Nausea / Vomiting
  - Papilloedema
  - Coma
- Local (focal) brain dysfunction
  - Compression – Hemiparesis/hemianopia
  - Infiltration
  - Seizure
  - CN palsy
Pressure Effects

Seizures

Systemic / hormonal Effects

Focal Effects

Acute Events

Elevated ICP

• Mass (SOL)
• Edema
• Hydrocephalus

Kelly Monro Doctrine

Brain tissue
CSF
Blood
Tumor
Pressure Effects
Seizures
Focal Effects
Acute Events
Systemic/hormonal Effects

Function of Brain
Motor & Sensation
Vision
Language
Memory & Emotion

Distribution of Control in Brain

Left brain-Right side
Right brain-Left side
**Indications for operation**

- To confirm the diagnosis
- Evidence of significant mass effect
- Relief of hydrocephalus
- Cytoreduction

**Preoperative Investigations**

- CT scan
- Magnetic Resonance Imaging (MRI) or angiography (MRA)
- Digital subtraction angiography (DSA)
- Work-up for primary disease

**General Pre-Op Treatment**

- Observation
- Dexamethasone
- Anticonvulsant
- Osmotherapy if acute deterioration

**Urgency of treatment**

- Depends on the mass effect of the tumour
- The rate of growth
- Associated hydrocephalus
- Preserving function e.g. vision
Classification: Typing & Grading

- WHO 1993
- Kleihues, Burger & Scheithauer

Grade I - Pilocytic Astrocytoma
Grade II - Low Grade Astrocytoma
Grade III - Anaplastic Astrocytoma
Grade IV - GBM (Glioblastoma Multiforme)

Prognosis & Median survival

- Glioblastoma: 9 Months
- Anaplastic glioma: 2 Years
- Low grade glioma: Long
- Pilocytic glioma: Good

Treatment

Surgery + Radiotherapy +/- Chemotherapy
Surgery

- **AIM**: Maximal removal of tumor without production of new neurological deficit.
- Gross total
- Subtotal (Debulking)
- Biopsy: Open vs stereotactic

Surgery

- Histopathology
- Immediate palliation
- Oncological control (Cytoreduction)
- Facilitate adjuvant therapies

Surgery

- **Median Survival**
  - Gross total resection: 90 weeks
  - Subtotal resection: 43 weeks

Ammirati 1987

Malignant Glioma: Role of Surgery

Berger Sem Oncol 21(2):172-185, 1994
**Surgery**

Benefit of radical surgery is Positive but modest

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**Minimal Invasive Neurosurgery with Maximal Safety**

Awake Craniotomy Brain Mapping

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**Glioma**

- Subcortical
- Cortical
- Infiltrative
- Eloquent area

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**Tumor at eloquent area**

- Maximal surgical removal
- Minimal neurological deficit
Contra-indications

- Existing irreversible deficit
  - Hemiparesis
  - Dysphasia

- Children
  - Cooperation
  - Immature brain

Awake Patients - Preparation

- Patient briefing & training
  - Psychological anticipation
  - Pain threshold
  - Intra-operative sequence of events

fMRI – Right hand

fMRI – Speech-Reading
fMRI – Speech-Naming

Images courtesy of Johann Wolfgang Goethe University Hospital, Frankfurt, Germany

MR Spectroscopy
Choice of TE

Formation of Metabolic Maps

CSI - Example of CSI maps
(1) Image-Navigation
Motor mapping

• Usually no need for intra-Op ECoG

• Localisation of central sulcus
  – Anatomy & Neuronavigation
  – Phase-reversal SSEP
    • Strip electrode

(2) Phase Reversal SSEP

(3) Direct Cortical Stimulation

Motor mapping

• Cortical stimulation
  – Ojemann Cortical Stimulator
  – Bipolar / biphasic stimulation
  – PW – 1ms
  – Frequency 60Hz
  – Current: 0.5mA to 15mA (Max. 20mA)
  – Stimulation probe parallel to gyrus
  – Stimulation of parafalcine cortex – Lower limb
Speech Mapping

- Intra-Op ECoG
  - GRASS EEG electrodes holder – “the Crown”
  - Maximal stimulation current
  - Seizure threshold – After-discharges (Ads)
- Counting
- Naming
  - Flash cards / Computer slides
    - Stimulation for 5 sec
    - Stimulations between every other slide
    - Speech disturbance
      - Speech arrest (Anomia)
      - Delay
      - Substitution with wrong name or mispronunciation
  - Repeat for confirmation
Intra-Op Seizure

- Prevention
  - Adequate to high normal range of AED
  - Intra-Op ECoG for Ads
- Seizure abortion
  - Iced saline (4'C) applied to cortex
  - Methohexital
  - Midazolam

Video
Glioma Surgery

Seeing the invisible

5-ALA (5-aminolevulinic acid)

- Elicits synthesis and accumulation of fluorescent porphyrins within malignant glioma tissue
- More complete resections of contrast-enhancing tumour
  (OR 3.28 95% CI 1.99-5.40, p<0.0001)

Walter Stummer et al. 2006
**Indication and contra-I**

**Indication**
- Malignant glioma for gross / near-gross total removal
- Expected minimum residual disease

**Contra-I**
- Porphyria/Pregnancy
- Debunking surgery
- Pre-existing fixed deficit
- Eloquent area (without mapping)

**Usage**
- 20mg/kg body weight
- 3-4 hours before surgery, orally
- Active from 3rd -12th hr
- Dark theatre: Ambient light: Neon tubes (red component)
- Photobleaching
- Photosensitivity (24 hours)

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**Fluorescence-guided surgery with 5-aminolevulinic acid for resection of malignant glioma: a randomised controlled multicentre phase III trial**

Walter Stummer, Ewa Polimnka, Thomas Klein, Ottmar Diete Wietse, Friedhelm Zwindler, Hans Jürgen Rothen, for the EALA-Glioma Study Group

<table>
<thead>
<tr>
<th>S-aminolevulinic acid (n=48)</th>
<th>White light (n=31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>No. of patients</td>
</tr>
<tr>
<td>Median (range)</td>
<td>59 (21-75)</td>
</tr>
<tr>
<td>&gt;70</td>
<td>25 (41%)</td>
</tr>
<tr>
<td>&gt;80</td>
<td>11 (35%)</td>
</tr>
<tr>
<td>Karnovsky performance scale</td>
<td></td>
</tr>
<tr>
<td>70-80</td>
<td>25 (41%)</td>
</tr>
<tr>
<td>80+</td>
<td>11 (35%)</td>
</tr>
<tr>
<td>Tumor location</td>
<td></td>
</tr>
<tr>
<td>Hemispheres</td>
<td>65 (44%)</td>
</tr>
<tr>
<td>&gt;Hemisphere</td>
<td>11 (35%)</td>
</tr>
<tr>
<td>Eloquent area</td>
<td></td>
</tr>
<tr>
<td>&lt;Eloquent area</td>
<td>93 (67%)</td>
</tr>
<tr>
<td>US National Institute of Health stroke score</td>
<td></td>
</tr>
<tr>
<td>Median (range)</td>
<td>1 (0-4)</td>
</tr>
</tbody>
</table>

Pathological analysis
- Diffusing glioma (grade II): 6 (11%)
- Anaplastic astrocytoma (grade III): 2 (2%)
- Mixed oligoastrocytoma (grade II): 0
- Glioblastoma (grade IV): 9 (18%)
- Glioblastoma multiforme (grade IV): 1 (2%)

**Outcomes Assessment**

- **Primary outcomes**
  - No. of patients without residual
  - 6-month PFS

- **Secondary outcomes**
  - Post-Op MRI residual volume
  - Overall survival
  - Neurological deficit
  - Toxic effects
Max. Resection vs Neurological deficit

“*It is the responsibility of the surgeon to decide how far he is prepared to remove fluorescing tissue*”

5-ALA fluorescence accumulation > contrast-enhancement in MRI

Summary

5-ALA is a surgical adjunct for maximum resection of malignant glioma. However, it does not preserve function or avoid operative neurological deficit. Instead it may increase the chance of neurological deficit in certain groups of patients without intra-Op monitoring.
Conclusion

• Maximal surgical removal of the malignant glioma provides modest benefit in survival and facilitates adjuvant therapies.
• Surgical risk should be balanced and neurological complications should be avoided as much as possible.
• Awake craniotomy and cortical mapping is advised for tumor locating at or near eloquent cortex.

Intratumoral Chemotherapy

• Overcoming BBB
• Increase local drug conc.
• Minimizing systemic side effects
• Sustain release drug for specific cell cycle phase

Placebo-controlled trial of safety and efficacy of intraoperative controlled delivery by biodegradable polymers of chemotherapy for recurrent gliomas

Henry Brem, Steven Piantadosi, Peter C Burger, Michael Walker, Robert Selker, Nicholas A Vick, Keith Black, Michael Sioli, Steven Brem, Gerard Mohr, Paul Muller, Richard Morawetz, S Clifford Schoed, for the Polymer Brain Tumor Treatment Group

• Henry Brem 1995
• Lancet
• Prospective
• Randomized
• Placebo controlled
• MS 31 vs 23 weeks
Local Chemotherapy - Gliadel

- Biodegradable 1,3-bis(2-chloroethyl)-1-nitrosourea (BCNU) wafer
- Contains 3.85% BCNU to be release within 2-3 weeks
- BCNU
- Ability to cross blood-brain barrier
- Small fraction of dose at interested site with systemic toxicity

A phase 3 trial of local chemotherapy with biodegradable carmustine (BCNU) wafers (Gliadel wafers) in patients with primary malignant glioma$^{1,2}$

Manfred Westphal, Dana C. Hilt, Enoch Bortey, Patrick Delavault, Robert Olivaress, Peter C. Warnke, Ian R. Whittle, Juha Jääskeläinen, and Z. p-----

Department of Neurosurgery, University Hospital Eppendorf, Hamburg, Germany; Neuro-Oncology Lab, April 2003
Pharmaceuticals, Baltimore, MD 21224, USA (D.C.H., E.B.); Aventis Pharma France, Paris, France (P.D., R.O.); Walton Centre for Neurology and Neurosurgery, Liverpool, UK (P.C.W.); Department of Neurosurgery, Western General Hospital, Edinburgh, Scotland (I.R.W.), Department of Neurosurgery, Tapiola, Finland (J.J.); Department of Neurosurgery, Chaim Sheba Medical Center, Tel-Aviv, Israel (Z.K.)

- Prospective multi-centre, double-blinded, placebo-controlled trial
- Dec 1997 - June 1999
- n = 240

2-3 years follow-up

Fig. 1. Kaplan-Meier survival curve (ITT population)
Table 4. Neurologic adverse events

<table>
<thead>
<tr>
<th>Adverse event</th>
<th>Gladel wafer n = 120</th>
<th>Placebo n = 120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nervous system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal gait</td>
<td>6 (5.0)</td>
<td>6 (5.0)</td>
</tr>
<tr>
<td>Amnesia</td>
<td>11 (9.2)</td>
<td>12 (10.0)</td>
</tr>
<tr>
<td>Aphasia</td>
<td>21 (17.5)</td>
<td>22 (18.3)</td>
</tr>
<tr>
<td>Ataxia</td>
<td>7 (5.8)</td>
<td>5 (4.2)</td>
</tr>
<tr>
<td>Brain edema</td>
<td>27 (22.5)</td>
<td>23 (19.2)</td>
</tr>
<tr>
<td>Confusion</td>
<td>28 (23.3)</td>
<td>25 (20.8)</td>
</tr>
<tr>
<td>Convulsion</td>
<td>40 (33.3)</td>
<td>45 (37.5)</td>
</tr>
<tr>
<td>Depression</td>
<td>19 (15.8)</td>
<td>12 (10.0)</td>
</tr>
<tr>
<td>Dizziness</td>
<td>6 (5.0)</td>
<td>11 (9.2)</td>
</tr>
<tr>
<td>Facial paralysis</td>
<td>8 (6.7)</td>
<td>5 (4.2)</td>
</tr>
<tr>
<td>Grand mal convulsion</td>
<td>6 (5.0)</td>
<td>5 (4.2)</td>
</tr>
<tr>
<td>Hemiplegia</td>
<td>49 (40.8)</td>
<td>53 (44.2)</td>
</tr>
<tr>
<td>Incoordination</td>
<td>3 (2.5)</td>
<td>8 (6.7)</td>
</tr>
<tr>
<td>Intracranial hypertension</td>
<td>11 (9.2)</td>
<td>2 (1.7)</td>
</tr>
<tr>
<td>Neuropathy</td>
<td>8 (6.7)</td>
<td>12 (10.0)</td>
</tr>
<tr>
<td>Speech disorder</td>
<td>13 (10.8)</td>
<td>10 (8.3)</td>
</tr>
</tbody>
</table>

Table 3. Time to neuroperformance decline (ITT Population)

<table>
<thead>
<tr>
<th>Neuroperformance measure</th>
<th>Gladel wafer n = 120</th>
<th>Placebo n = 120</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vital signs</td>
<td>54.9</td>
<td>49.1</td>
<td>0.010</td>
</tr>
<tr>
<td>Level of consciousness</td>
<td>52.1</td>
<td>45.4</td>
<td>0.016</td>
</tr>
<tr>
<td>Personality</td>
<td>51.7</td>
<td>40.0</td>
<td>0.008</td>
</tr>
<tr>
<td>Speech</td>
<td>49.6</td>
<td>36.7</td>
<td>0.003</td>
</tr>
<tr>
<td>Visual status</td>
<td>44.0</td>
<td>42.4</td>
<td>0.087</td>
</tr>
<tr>
<td>Fundus</td>
<td>55.1</td>
<td>46.3</td>
<td>0.007</td>
</tr>
<tr>
<td>Cranial nerves II, IV, VI</td>
<td>54.9</td>
<td>49.1</td>
<td>0.016</td>
</tr>
<tr>
<td>Cranial nerves, other</td>
<td>54.3</td>
<td>46.3</td>
<td>0.003</td>
</tr>
<tr>
<td>Motor status</td>
<td>45.4</td>
<td>31.4</td>
<td>0.013</td>
</tr>
<tr>
<td>Sensory status</td>
<td>51.6</td>
<td>44.1</td>
<td>0.024</td>
</tr>
<tr>
<td>Cerebellar status</td>
<td>54.1</td>
<td>46.7</td>
<td>0.011</td>
</tr>
</tbody>
</table>

* Stratified by country

Table 2. Perioperative morbidity in patients receiving tumor resection for malignant glioma (World Health Organization grade III/IV)

<table>
<thead>
<tr>
<th>Variable</th>
<th>All patients (n = 103)</th>
<th>Gladel (n = 288)</th>
<th>Non-Gladel (n = 729)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary embolism</td>
<td>41 (4.0%)</td>
<td>14 (4.9%)</td>
<td>27 (3.7%)</td>
<td>.488</td>
</tr>
<tr>
<td>Deep-vein thrombosis</td>
<td>36 (3.5%)</td>
<td>18 (6.3%)</td>
<td>18 (5.2%)</td>
<td>.326</td>
</tr>
<tr>
<td>Wound healing</td>
<td>5 (0.5%)</td>
<td>2 (1.7%)</td>
<td>3 (0.4%)</td>
<td>.626</td>
</tr>
<tr>
<td>Primary reaction (n = 613)</td>
<td>5 (0.5%)</td>
<td>3 (0.3%)</td>
<td>2 (0.2%)</td>
<td>.178</td>
</tr>
<tr>
<td>Revision reaction (n = 490)</td>
<td>6 (3.5%)</td>
<td>0 (0.2%)</td>
<td>6 (1.2%)</td>
<td>.075</td>
</tr>
<tr>
<td>Surgical site infection</td>
<td>21 (2.1%)</td>
<td>8 (2.8%)</td>
<td>13 (1.8%)</td>
<td>.333</td>
</tr>
<tr>
<td>Primary reaction (n = 613)</td>
<td>14 (0.5%)</td>
<td>6 (2.5%)</td>
<td>8 (1.5%)</td>
<td>.333</td>
</tr>
<tr>
<td>Revision reaction (n = 490)</td>
<td>36 (4.0%)</td>
<td>16 (4.0%)</td>
<td>20 (4.1%)</td>
<td>.592</td>
</tr>
<tr>
<td>Cerebrospinal fluid leak</td>
<td>21 (2.1%)</td>
<td>8 (2.8%)</td>
<td>13 (1.8%)</td>
<td>.333</td>
</tr>
<tr>
<td>Seizure</td>
<td>156 (15.4%)</td>
<td>42 (14.6%)</td>
<td>114 (15.7%)</td>
<td>.650</td>
</tr>
<tr>
<td>Symptomatic malignant edema a</td>
<td>21 (2.3%)</td>
<td>5 (1.9%)</td>
<td>16 (2.2%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Meningitis</td>
<td>3 (3%)</td>
<td>1 (1.3%)</td>
<td>2 (3%)</td>
<td>1.00</td>
</tr>
</tbody>
</table>

a There was no difference in the incidence of 3-month morbidity between patients receiving vs. those not receiving Gladel wafers. Gladel patients included 166 treated with primary tumor resection and 122 with revision resection. Non-Gladel patients included 447 treated with primary tumor resection and 278 with revision resection.

A “local” oncologist
Is it worth doing?

Pathophysiology

- Destruction of BBB due to metastases result in tumour contrast enhancement and surrounding edema

Epidemiology

- Autopsy: 20-40% of all cancer deaths have brain metastasis
  - Landis et al 1998: ~125,000 (American Cancer Society: 564,800 cancer deaths)
  - More cancer in general in an aging populations
  - Better imaging
  - Better control of primary disease
**Primary Tumour**

<table>
<thead>
<tr>
<th>Primary tumour</th>
<th>% of brain metastasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung</td>
<td>38</td>
</tr>
<tr>
<td>Breast</td>
<td>19</td>
</tr>
<tr>
<td>Melanoma</td>
<td>13</td>
</tr>
<tr>
<td>Renal</td>
<td>4</td>
</tr>
<tr>
<td>Unknown primary</td>
<td>1</td>
</tr>
<tr>
<td>Others</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

- Relative multiplicity of brain metastasis varies with primary tumour
- Overall 30-40% are solitary

**Localization of metastatic tumors**

- Tumor emboli: 80% in cerebrum, 15% in posterior fossa, 5% in brainstem
- "Soil & seed"

**Symptoms**

- Up to two-third of all metastases are symptomatic at some time in life, due to raise ICP or neuronal damage
- 15% of cancer firstly presented with brain metastasis

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>% of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>40 - 50%</td>
</tr>
<tr>
<td>Hemiparesis</td>
<td>~40%</td>
</tr>
<tr>
<td>Cognitive impairment</td>
<td>14%</td>
</tr>
<tr>
<td>Seizure</td>
<td>12%</td>
</tr>
<tr>
<td>Ataxia</td>
<td>7%</td>
</tr>
<tr>
<td>Others</td>
<td>16%</td>
</tr>
<tr>
<td>No symptom</td>
<td>~7%</td>
</tr>
</tbody>
</table>

**Radiation Therapy Oncology Group (RTOG)**

- 1200 patients from 1979-1993 (WBI)
  - Recursive Prognostic Analysis (RPA)
    - A statistical methodology which creates a regression tree according to prognostic significant

<table>
<thead>
<tr>
<th>Class</th>
<th>Median Survival</th>
<th>Patients</th>
</tr>
</thead>
</table>
| 1     | 7.1 months      | KPS >= 70
|       |                  | Controlled primary disease
|       |                  | Age < 65
|       |                  | No systemic metastasis |
| 2     | 4.2 months      | Not class 1 or 3 |
| 3     | 2.3 months      | KPS <70 |
**Aggressive Treatments**

- Aggressive treatment with RS, MS, WBI
  - Pollock BE *J Neurooncol* 2003
  - 52 patients from 1997-2000
- Age: 58 y.o.; KPS: 90; Tumour no.: 3
  - Overall medium survival: 15.5 months
  - One year: 63%; Two years: 27%
- Class 1: 19 months
- Class 2: 13 months
- Class 3: 8 months

**Suggestion**

*Aggressive treatments to class 1 and 2 patients with controlled primary and limited no. of brain metastasis*

**WBI or Surgery?**

- Vecht CJ *Ann Neurol* 1993
- Prospective randomized trial
- 63 patients with *single metastasis*, stratified

<table>
<thead>
<tr>
<th></th>
<th>WBI alone</th>
<th>Surgery + WBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median survival</td>
<td>7 months</td>
<td>12 months</td>
</tr>
<tr>
<td>Functional</td>
<td>4 months</td>
<td>9 months</td>
</tr>
<tr>
<td>independent survival</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Patient with progressive extracranial cancer carry poor survival (5 months) irrespective of treatment

*Functional status* improve rapid and longer than WBI
Surgery +/- WBI

- Patchell RA (*JAMA* 1998)
- Randomized trial:
  - 95 patients post-op.

<table>
<thead>
<tr>
<th></th>
<th>WBI (49)</th>
<th>Observe (46)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intracranial recurrence</td>
<td>9 (18%)</td>
<td>32 (70%)</td>
</tr>
<tr>
<td>original site</td>
<td>5 (10%)</td>
<td>21 (46%)</td>
</tr>
<tr>
<td>other site</td>
<td>7 (14%)</td>
<td>17 (37%)</td>
</tr>
<tr>
<td>Death due to CNS cause</td>
<td>6/43 (14%)</td>
<td>17/39 (44%)</td>
</tr>
</tbody>
</table>

- However, there’s no survival benefit

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**Stereotactic Radiosurgery**

1. Stereotactic co-ordinate system
   - Rigid head-mounted frame
   - MRI / CT / DSA
2. Deliver single high dose radiation accurately focusing at the target
   - Rapid radiation dose fall off at boundary

**Radiosurgery-Lethal hit vs Radiotherapy-Diff. repair**

- Stereotactic Radiosurgery – SRS
- Stereotactic Radiotherapy – SRT
- Conventional Radiotherapy
Types of Radiosurgery

- Gamma knife – Cobalt 60
- Linear Accelerator (LINAC)

Current Practice

- Treatment for resectable small (<3cm) single brain metastasis is still under debate
- Awaiting prospective randomized trial

<table>
<thead>
<tr>
<th></th>
<th>Surgery</th>
<th>Radiosurgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>Large</td>
<td>&lt;3cm</td>
</tr>
<tr>
<td>Location</td>
<td>Non-eloquent</td>
<td>Eloquent</td>
</tr>
<tr>
<td>Symptom</td>
<td>Symptomatic</td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>Systemic condition</td>
<td>Tolerate operation</td>
<td>Non-tolerate</td>
</tr>
<tr>
<td>Chemotherapy</td>
<td>Risk of haemorrhage</td>
<td></td>
</tr>
</tbody>
</table>

Overall Survival

- Natural history: 1 month
- With Steroid: 2 months
- WBI: 3-6 months
- Surgery + WBI: 8-12 months
- Radiosurgery: 7-12 months
Meningioma

- Commonest benign brain tumor
- Arachnoid cap cell
- Extra-axial / shape margin / “dural tail”
- Calcification / Hyperostosis
- Locations
  - Convexity / Parafalcine / Parasagittal
  - Olfactory groove / Sphenoidal ridge / Tentorial

Treatment for Meningioma

- Expectant policy
- Surgery

<table>
<thead>
<tr>
<th>Simpson Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total + Dura</td>
</tr>
<tr>
<td>2. Total + Coagulation</td>
</tr>
<tr>
<td>3. Total</td>
</tr>
<tr>
<td>4. Partial removal</td>
</tr>
<tr>
<td>5. Biopsy</td>
</tr>
</tbody>
</table>

- Radiotherapy

Pituitary Tumor

- Anterior pituitary gland
  - TSH, ACTH, GH, FSH/LH, Prolactin
- Posterior pituitary gland
  - ADH, Oxytocin
**Anatomy of pituitary gland**

- Cavernous sinus
  - CN
  - III
  - IV
  - V12
  - VI

- Optic chiasm
- Carotid artery
- Sphenoid sinus

**Pituitary tumor**

- Mass effect
  - Optic chiasm – Bitemporal hemianopsia
  - Third ventricle – hydrocephalus
  - Cranial nerves – III, IV, V, VI

- Hormonal disturbance
  - Functioning tumor
  - Non-functioning tumor

**Functioning tumor**

- TSH
- GH
- ACTH
- Prolactin
- FSH/LH

- Hyperthyroidism
- Acromegaly
- Cushing disease
- Galactorrhoea
- rare
Acromegaly

- DM / HT
- Cardiomegaly
- Carpal tunnel syndrome
- Joints degeneration

Transphenoidal Surgery

Transphenoidal approach for Pituitary tumour

Acoustic Neuroma

- Benign tumour
- Arise from VIII nerve (Vestibular schwannoma)
- Difficult surgical assess
- Hearing loss
Acoustic Neuroma

- Hearing loss / Tinnitus / Dysequilibrium
- Facial numbness / weakness
- Abnormal corneal reflex / Nystagmus
- Facial palsy (Rarely pre-Op)

Treatment for Acoustic neuroma

- Expectant policy
- Radiation therapy
- Surgery

- Symptoms (Hearing)
- Size & Growth rate
- Patients

Neurofibromatosis type-2 (NF2)

- Bilateral acoustic neuroma
- Chr. 22
- Neurofibroma
- Meningioma
- Glioma
- Schwannoma
- Pheochromocytoma
The End