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**SEMMELWEIS
UNIVERSITY**



Development of Complex Curricula for Molecular Bionics and Infobionics Programs within a consortial* framework**

Consortium leader

PETER PAZMANY CATHOLIC UNIVERSITY

Consortium members

SEMMELWEIS UNIVERSITY, DIALOG CAMPUS PUBLISHER

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BEVEZETÉS A FUNKCIONÁLIS NEUROBIOLÓGIÁBA

INTRODUCTION TO FUNCTIONAL NEUROBIOLOGY

By Imre Kalló

Contributed by: Tamás Freund, Zsolt Liposits, Zoltán Nusser, László Acsády, Szabolcs Káli, József Haller, Zsófia Maglóczky, Nórbert Hájós, Emilia Madarász, György Karmos, Miklós Palkovits, Anita Kamondi, Lóránd Eröss, Róbert Gábel, Zoltán Kisvárdai, Zoltán Vidnyánszky

Neurosurgery:

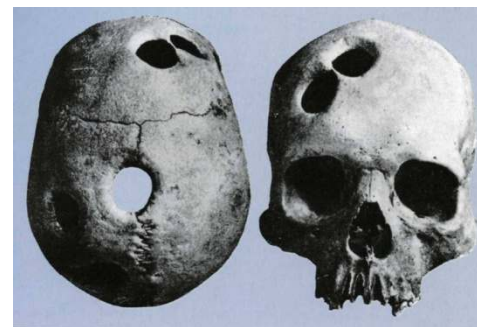
Surgical treatment of the diseases of neuronal networks

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Pázmány Péter Catholic University

Faculty of Information Technology

- I. Neurosurgical techniques
- II. Application fields of neurosurgery
 - 1. Neurooncology
 - 2. Parkinson's disease
 - 3. Treatment of epilepsy
 - 4. Treatment of pain



Aims of the neurosurgical treatments

Treatment of patients suffering from neurological diseases, which can not be cured off or sufficiently well with conservative approaches. Improving life quality, preventing deterioration of disease state, extending the period of quality life, palliative treatment and alleviation of pain.

Specializations in neurosurgery

- Neurotraumatology
- Pediatric neurosurgery
- Vascular neurosurgery
- Spinal neurosurgery
- Functional neurosurgery
- Neuro-oncology

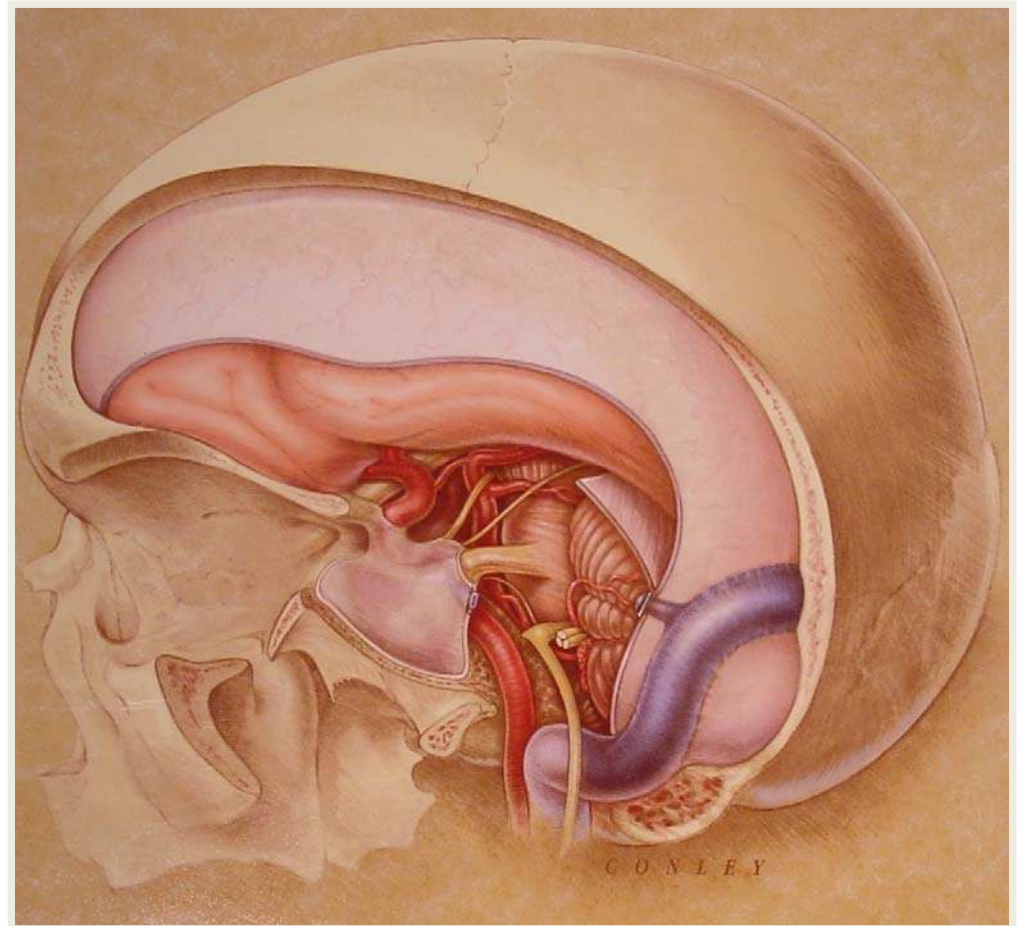
Factors influencing the therapeutic decisions of the neurosurgeon

- The preoperative clinical status of the patients
- Morphological data obtained with the modern imaging techniques (preoperative, intraoperative)
- Data of functional imaging techniques (preoperative)
- Electrophysiological data (preoperative, intraoperative)

Neurosurgical techniques

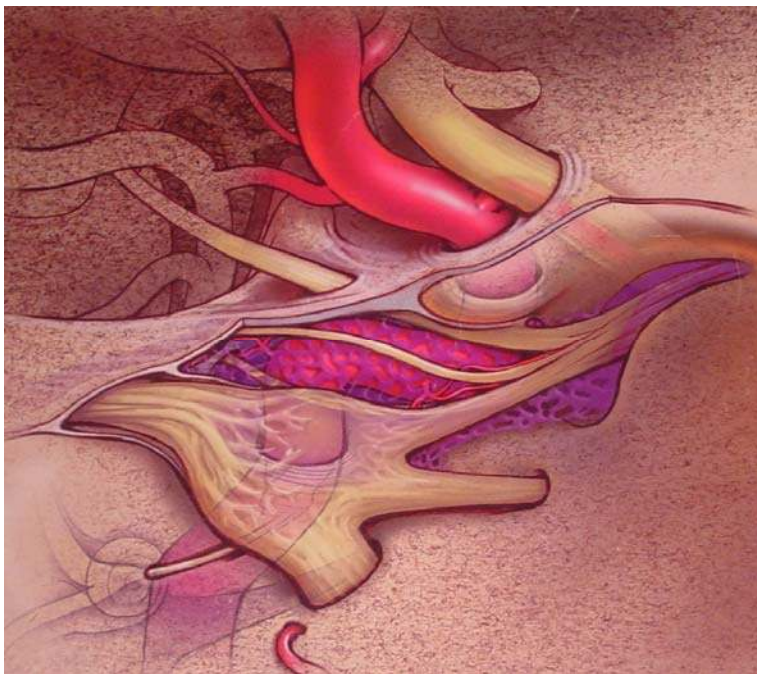
Minimally invasive surgical techniques

- From **the brain** point of view
- From the **patient's somatic** point of view
- Or from the **patient's psycho-somatic** point of view

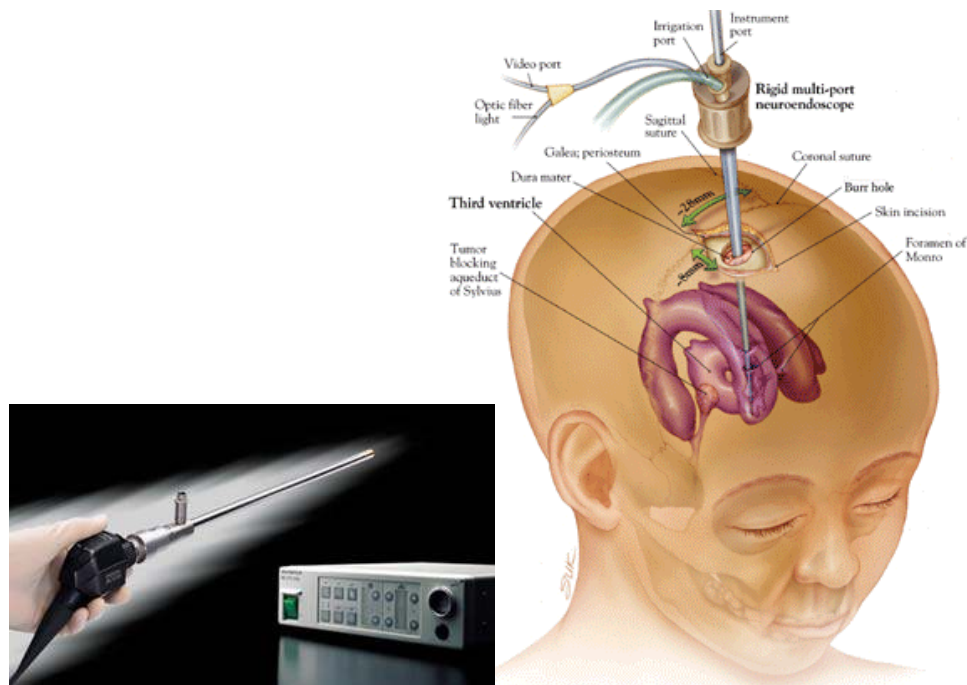


Neurosurgical techniques

Microscope-assisted intracysternal, or gyral microsurgery

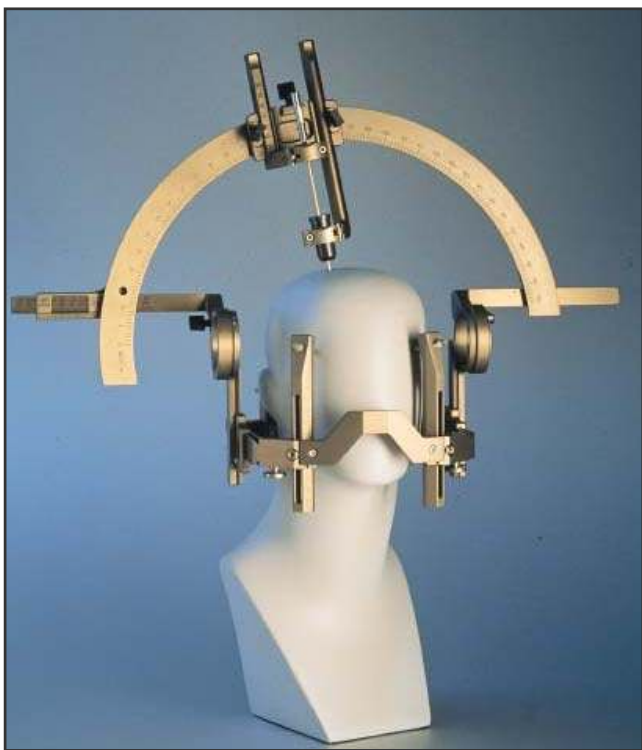


Endoscopic neurosurgery

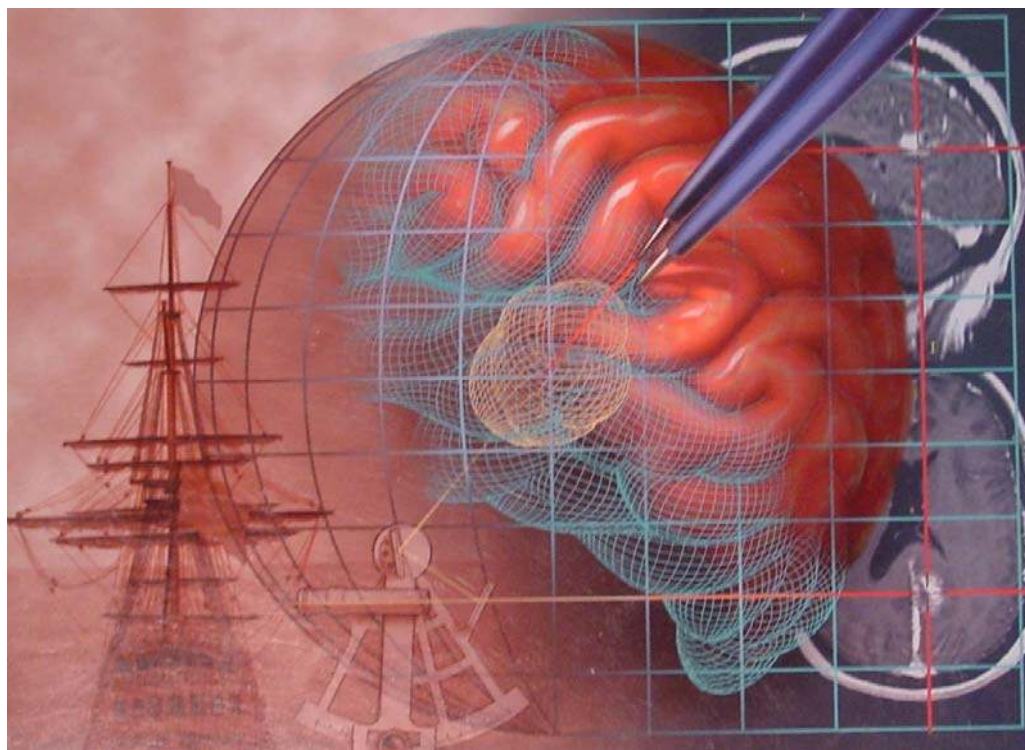


Neurosurgical techniques

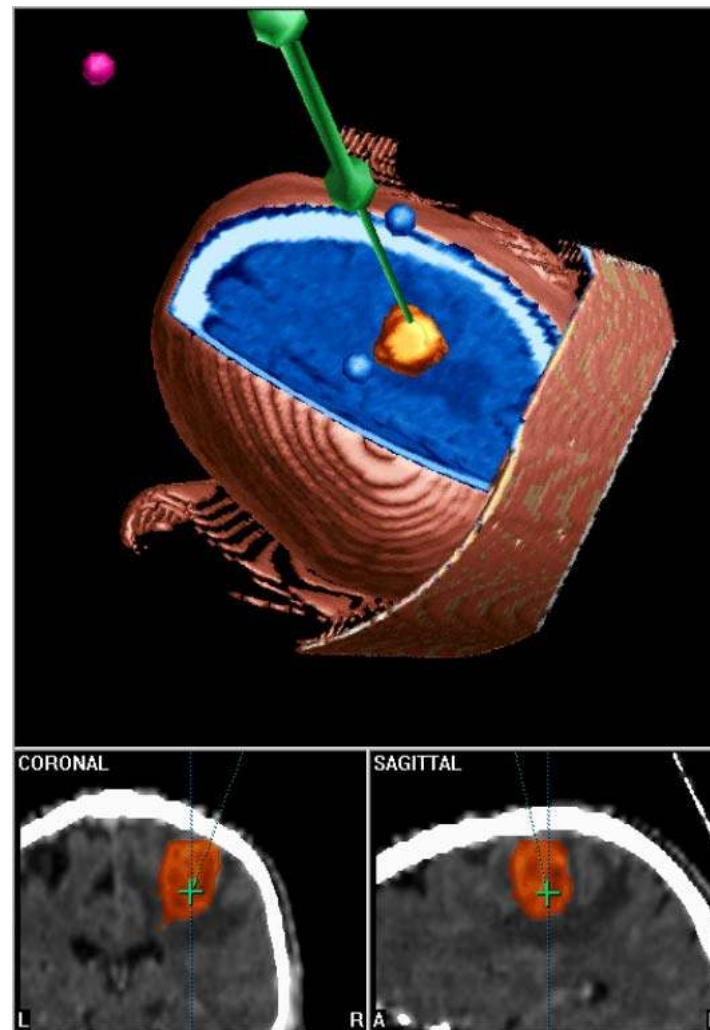
Stereotaxic neurosurgery



Neuronavigation- and robot-assisted microsurgery



Neurosurgical techniques: neuronavigation



Neurosurgical techniques: neuronavigation

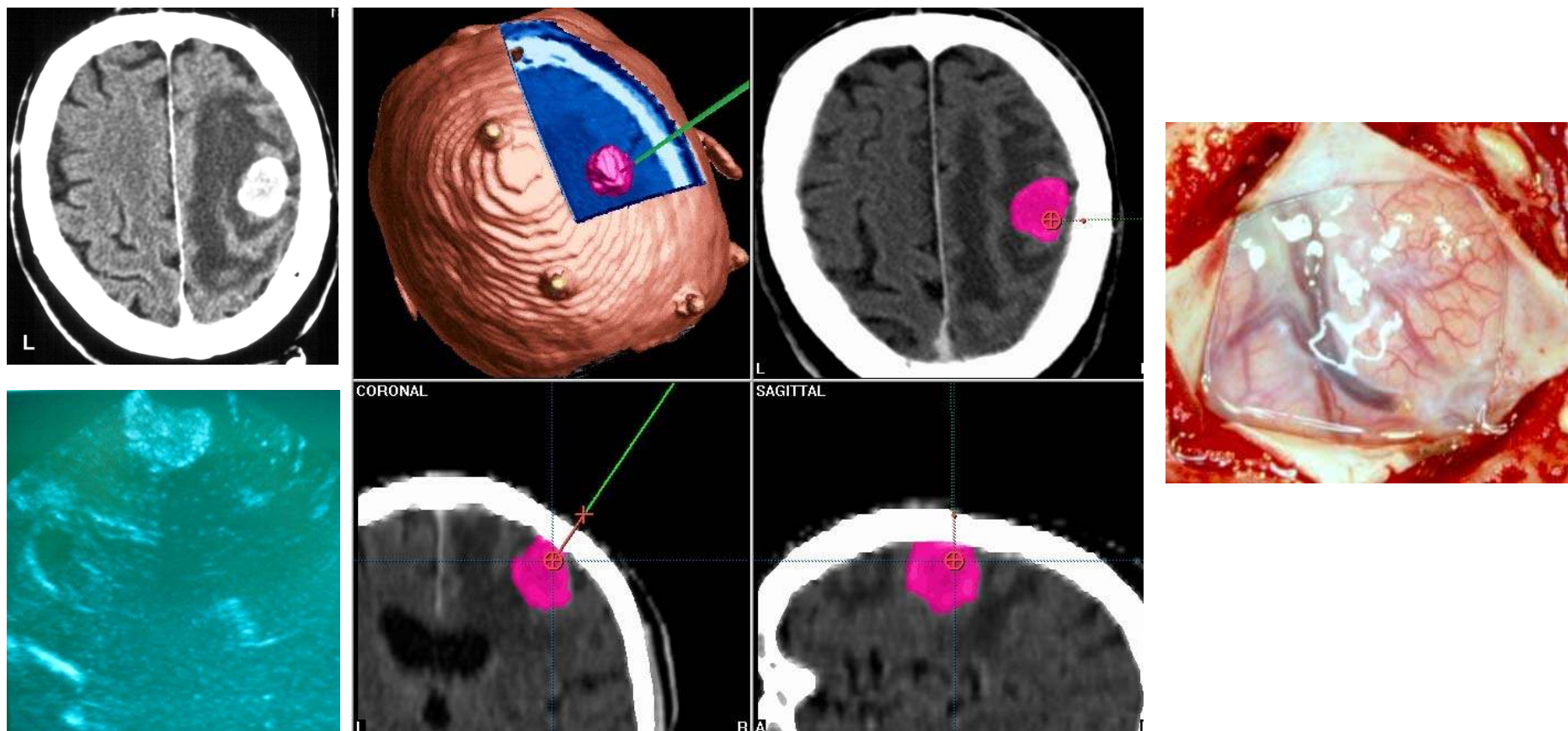
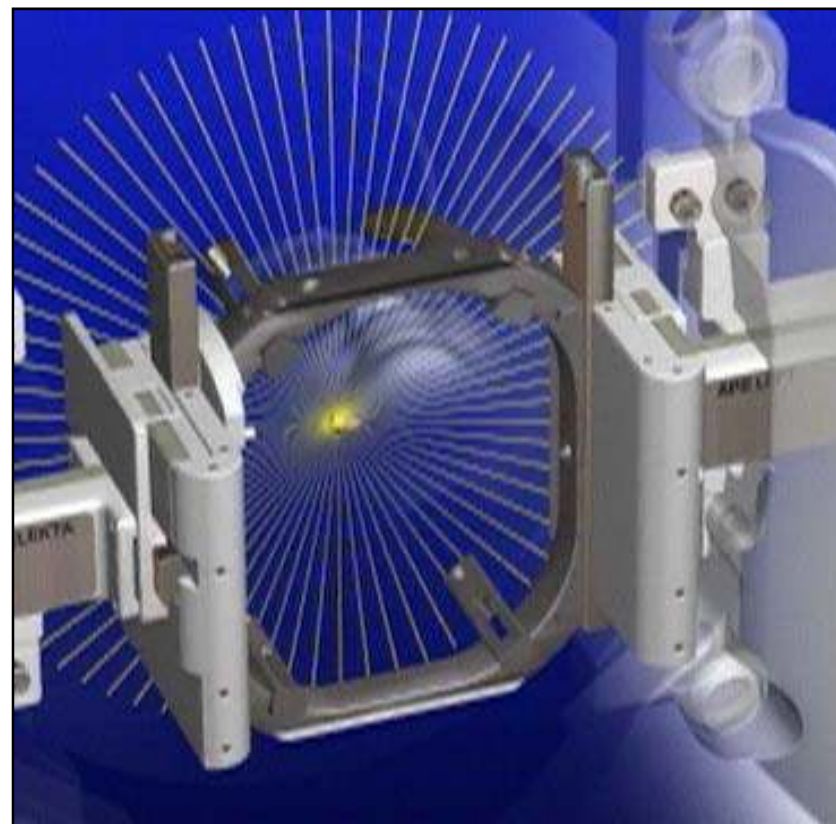


Image guided neurosurgery

Augmented Reality – overlay of pre-op image data onto scene

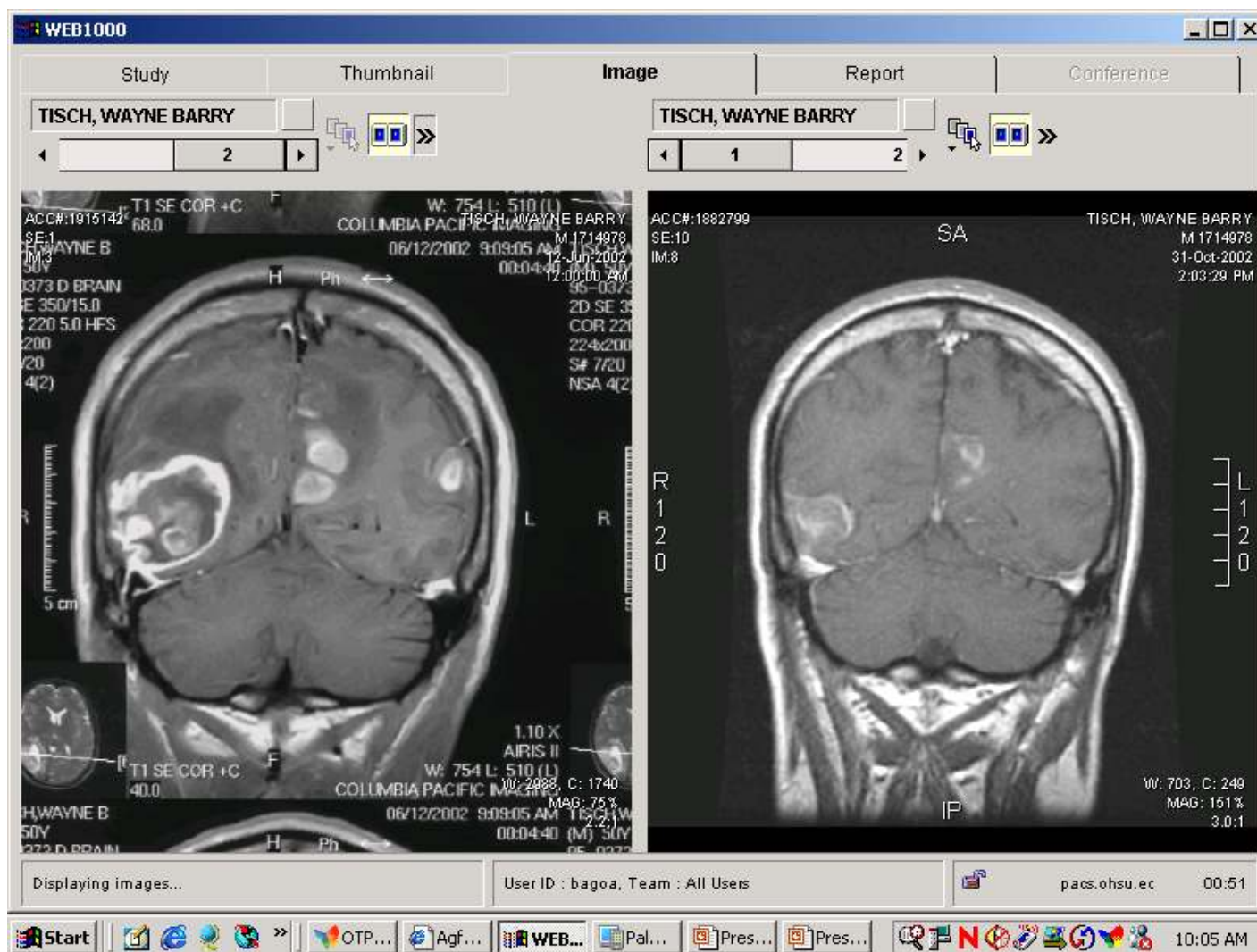


Neurosurgical techniques: gamma ray surgery

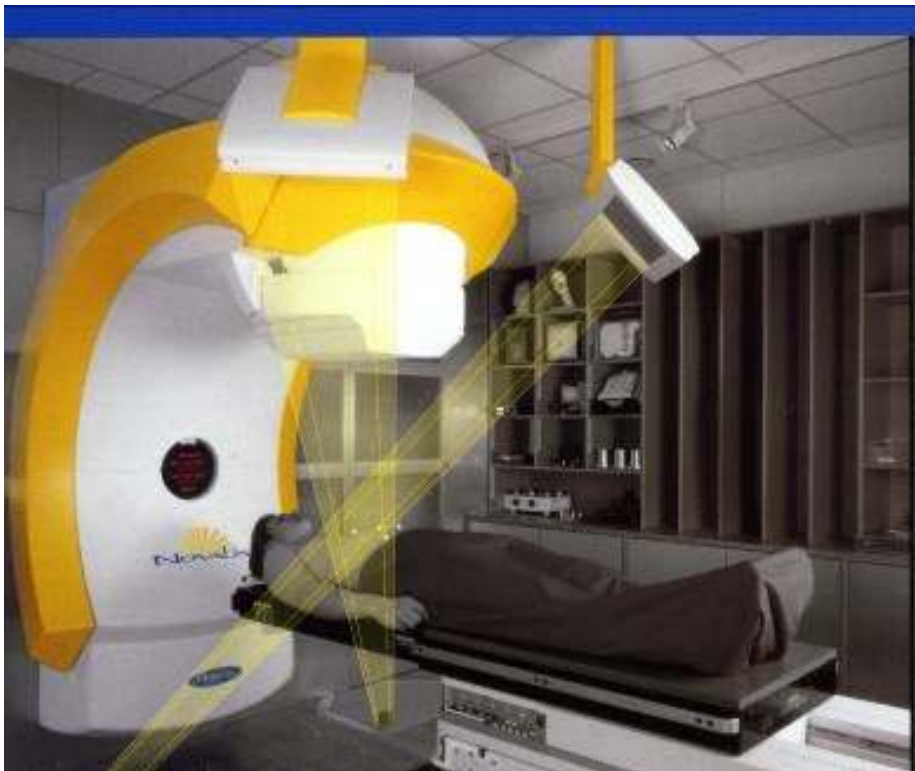


Gamma knife

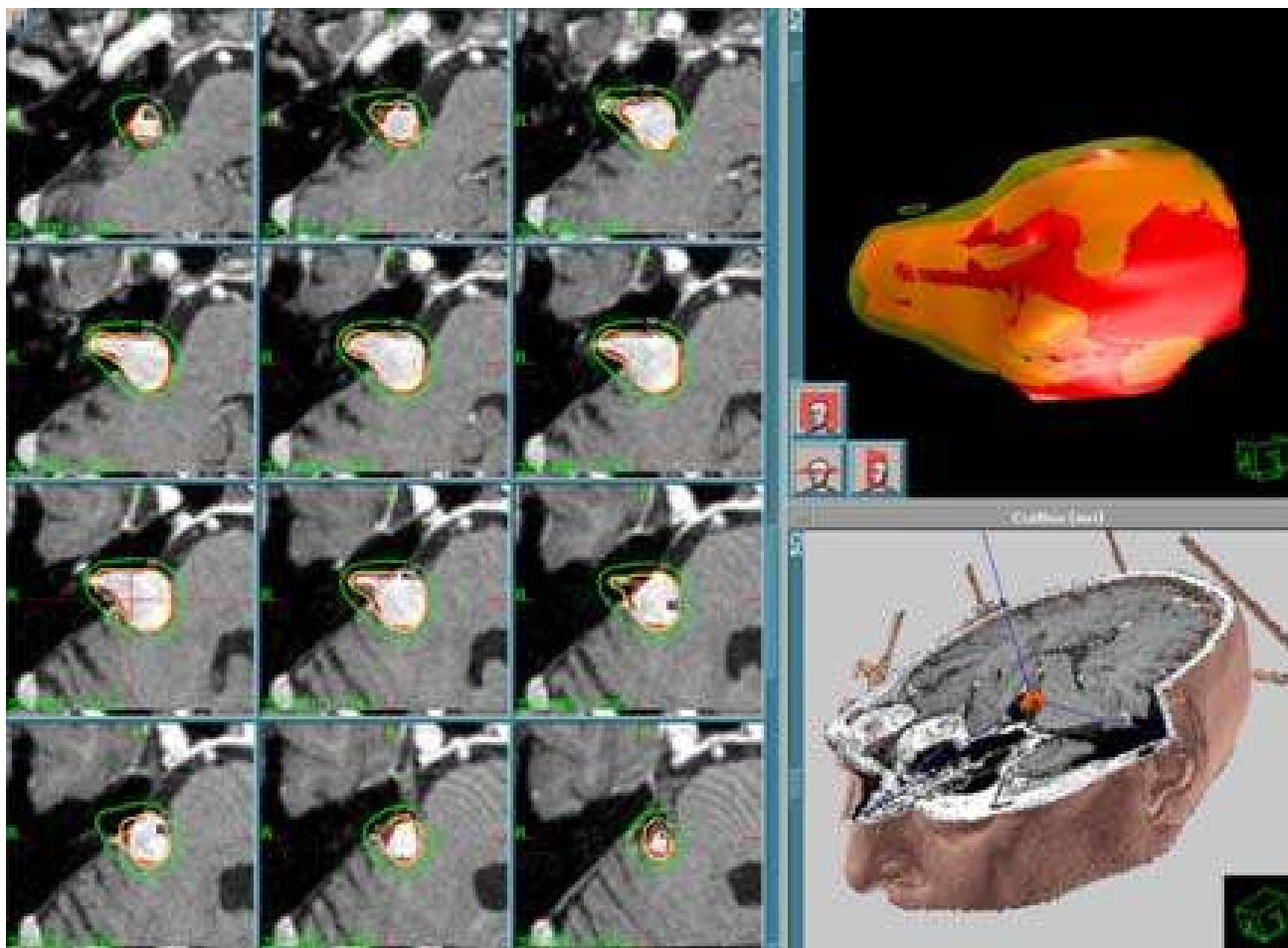




Neurosurgical techniques: linac and cyberknife



Neurosurgical techniques: radiation surgery



Neurosurgical techniques: robot-assisted surgery

Robot-assisted surgery / use of tele-manipulators



- Precise movements according to a plan
- Minified movements and tremor filtering

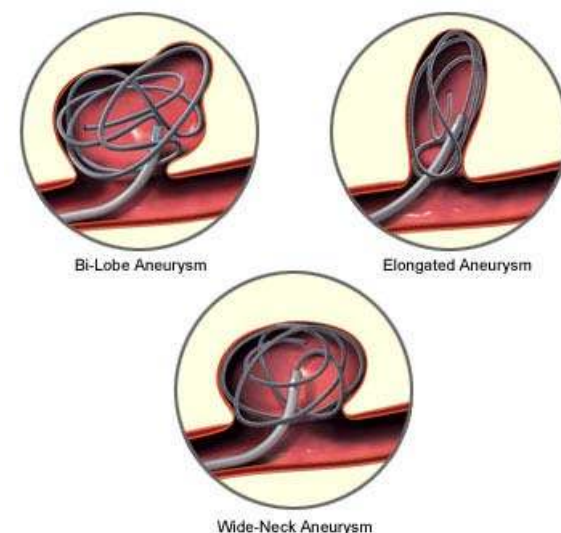
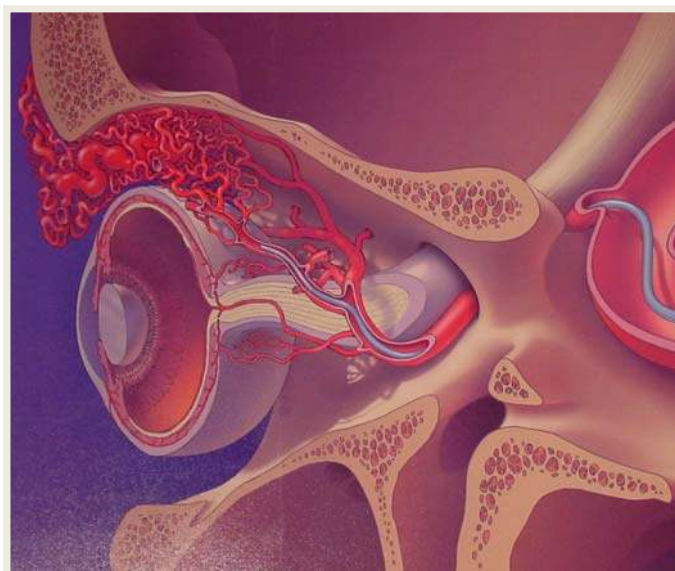


NeuroMate



Caspar

Neurosurgical techniques: endovascular neurosurgery



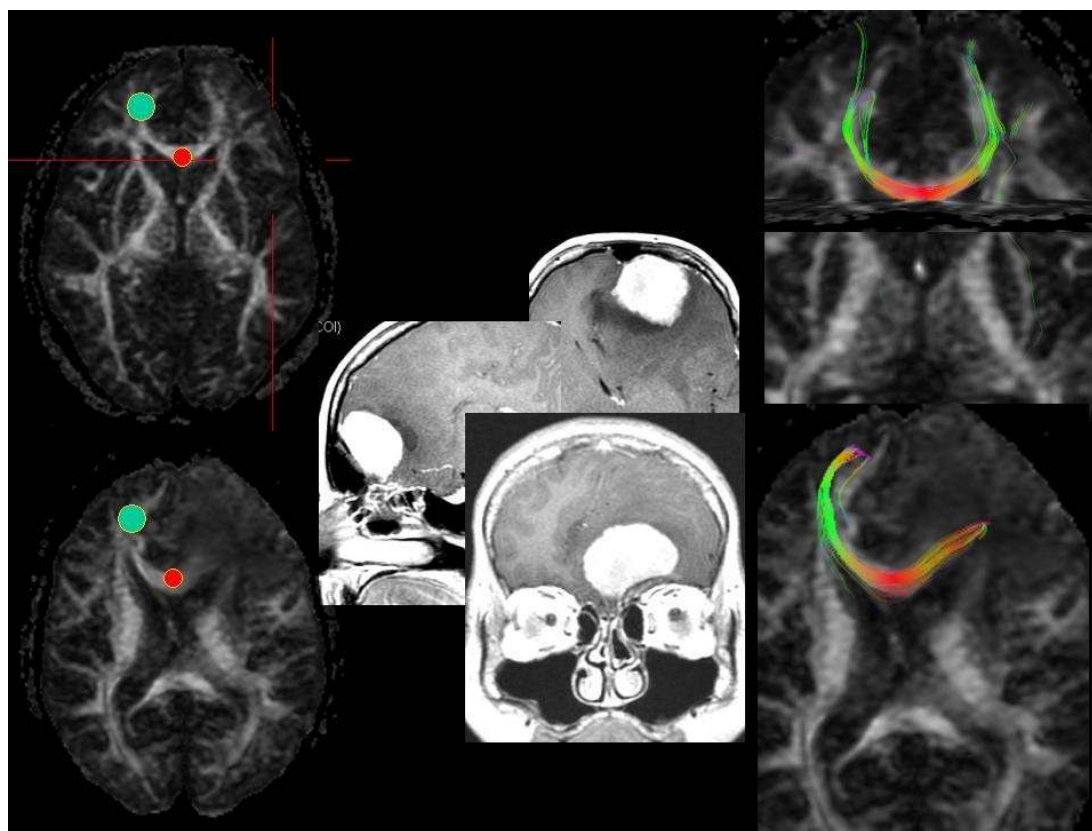
Neurosurgical techniques: preoperative imaging

- CT
- MR



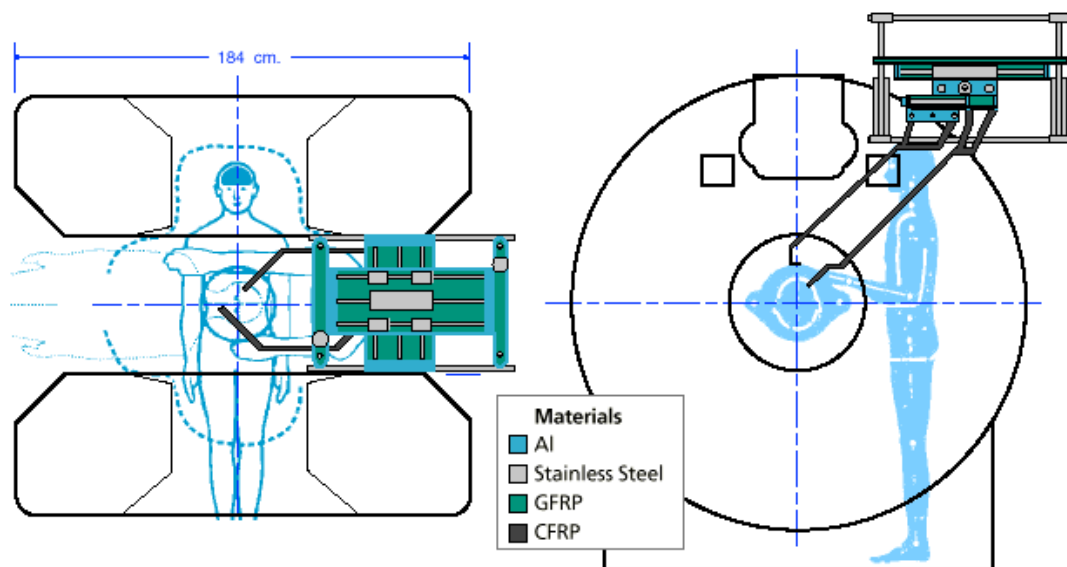
Neurosurgical techniques: preoperative imaging

- MR tractography



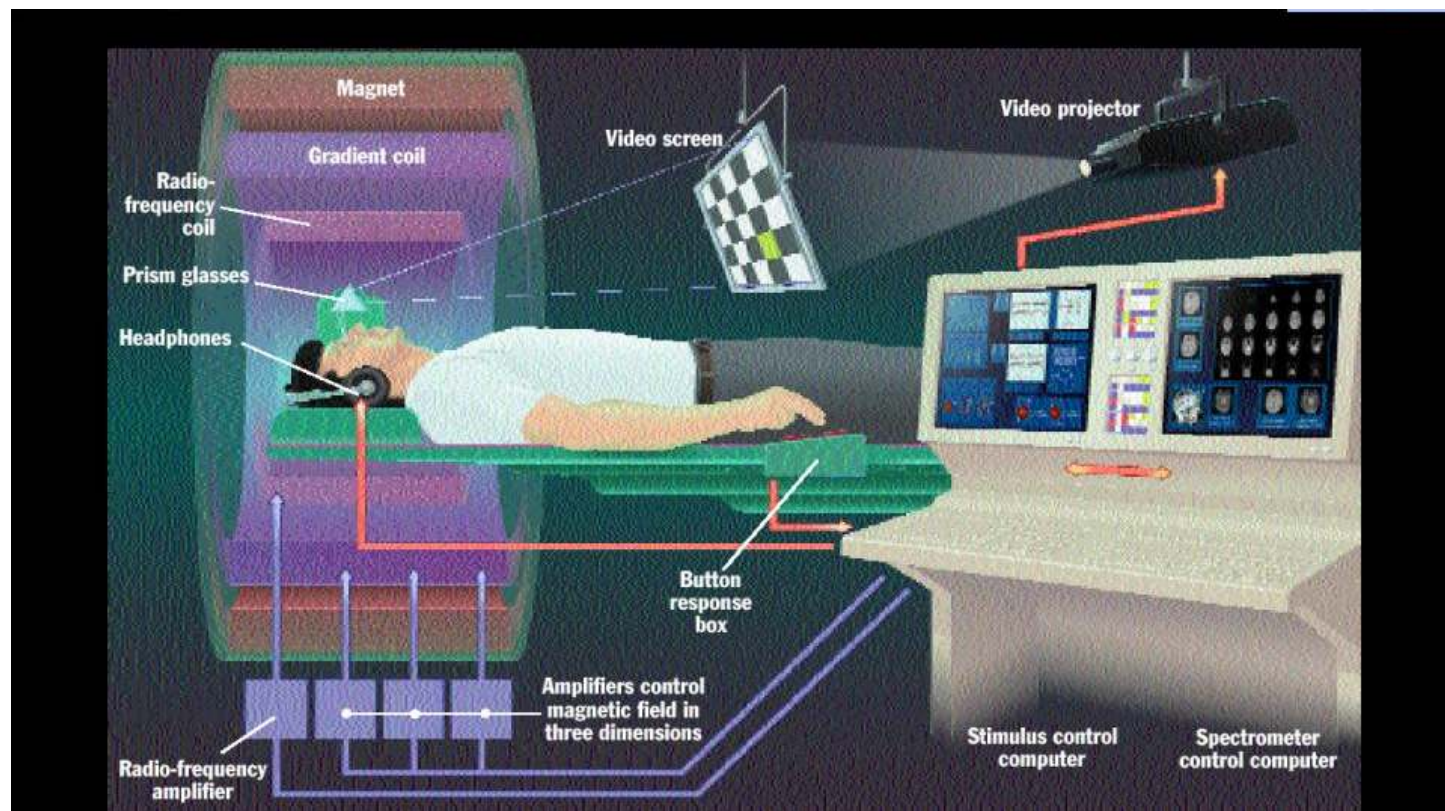
Neurosurgical techniques: intraoperative imaging

- Focused UH surgery
- Open MRI



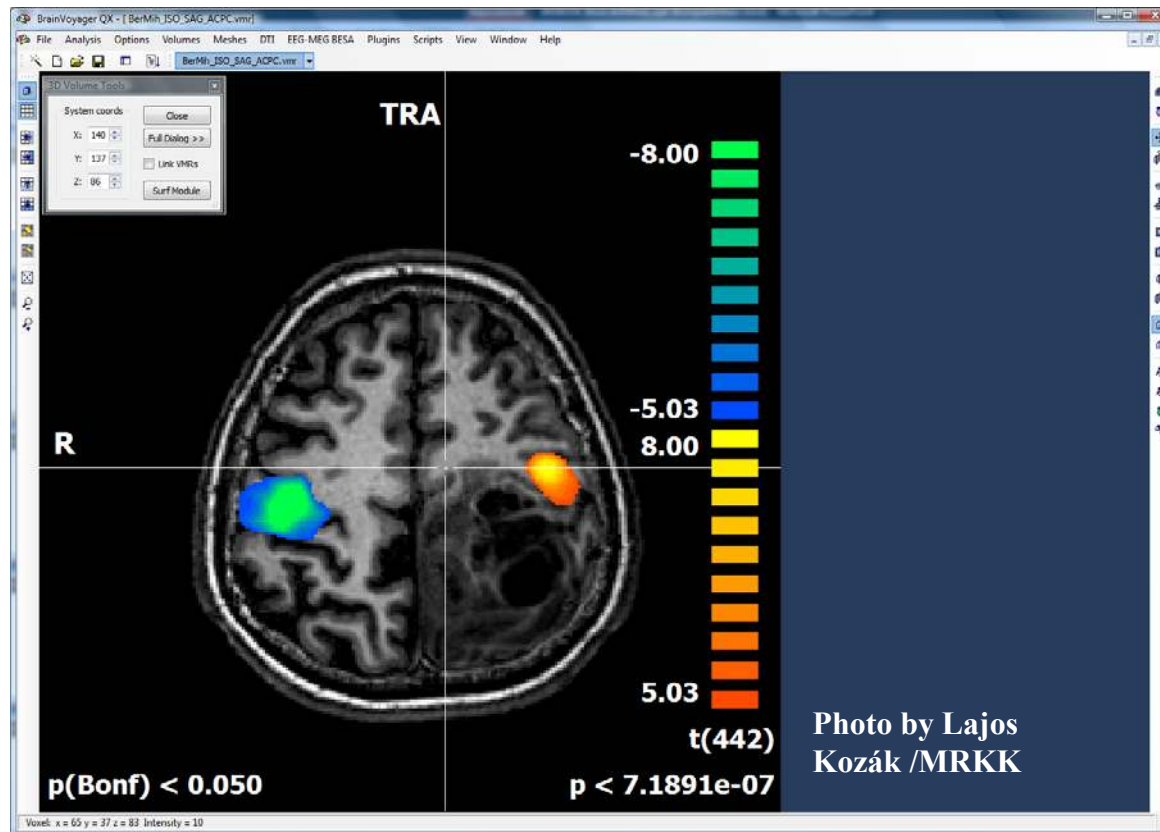
Neurosurgical techniques: intraoperative imaging

- Functional MR



Neurosurgical techniques: intraoperative imaging

- Functional MR: finger tapping



Application fields: neuro-oncology

Complex treatment of CNS

tumors

- Diagnostics: Is it tumor?
Histology?
- Therapy: surgical
radiation therapy
chemotherapy
- Supportive therapy, care
- Clinical research

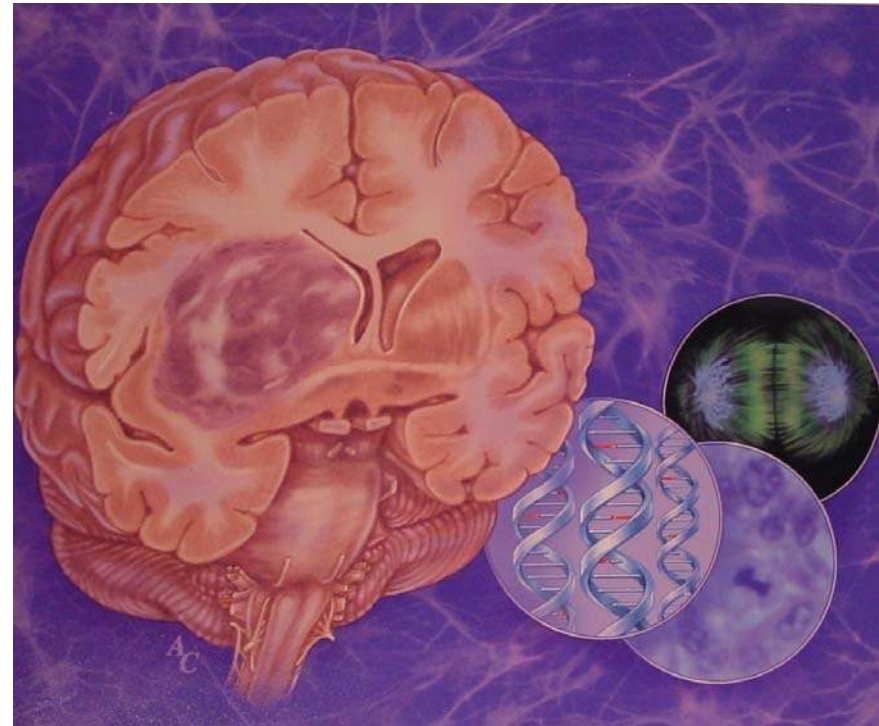
Significance

- Potentially life-threatening disease
- Number of patients with brain tumors ↑
- Number of surviving oncological patients ↑

Application fields: neuro-oncology

CNS tumors

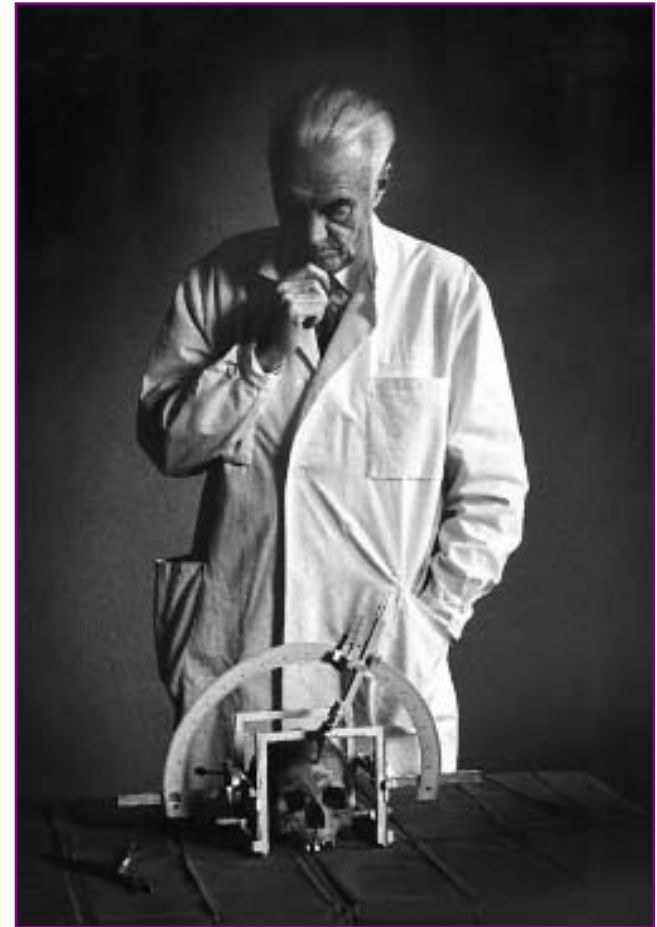
- 1.5% of all malignant tumors
- 2-2.3% of all causes of death
- 2.1% of death caused by tumors
- Neuroepithelial (intrinsic) tumors (48%)
- Extraparenchymal tumors (40-45%)
- Metastase (5-10%)



Neurosurgical techniques: stereotaxia

“The tools used by the surgeon must be adapted to the task and where the human brain is concerned they cannot be too refined.”

Lars Leksell, M.D., Ph.D., 1907-1986



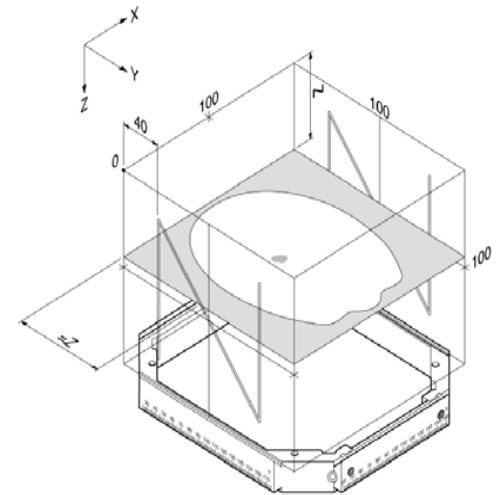
Neurosurgical techniques: stereotaxia

Aim:

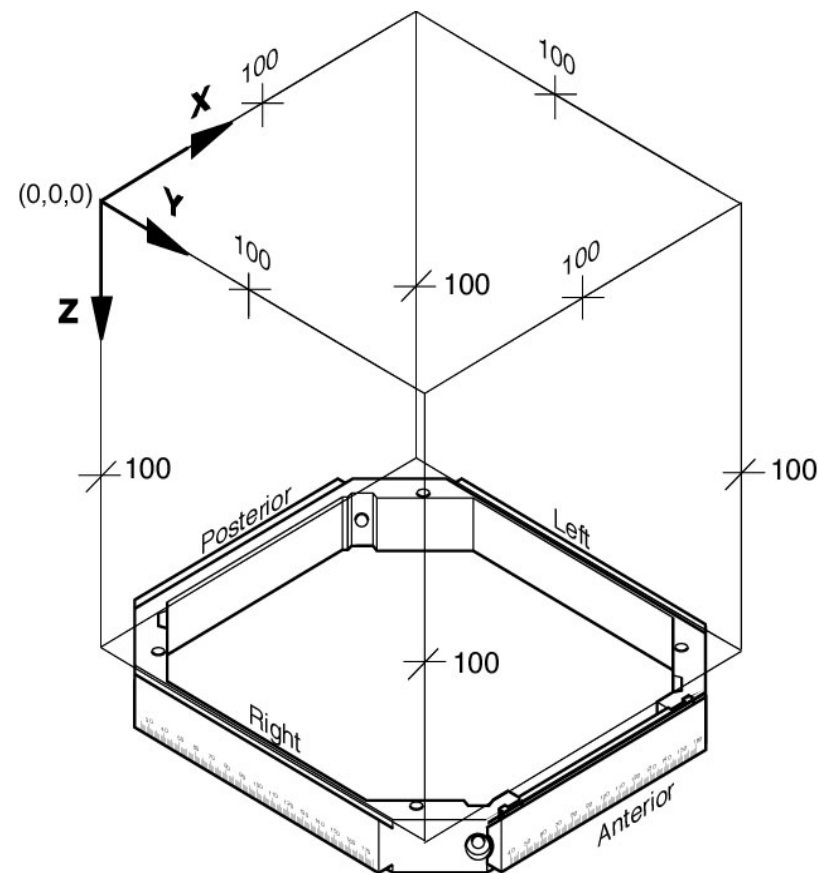
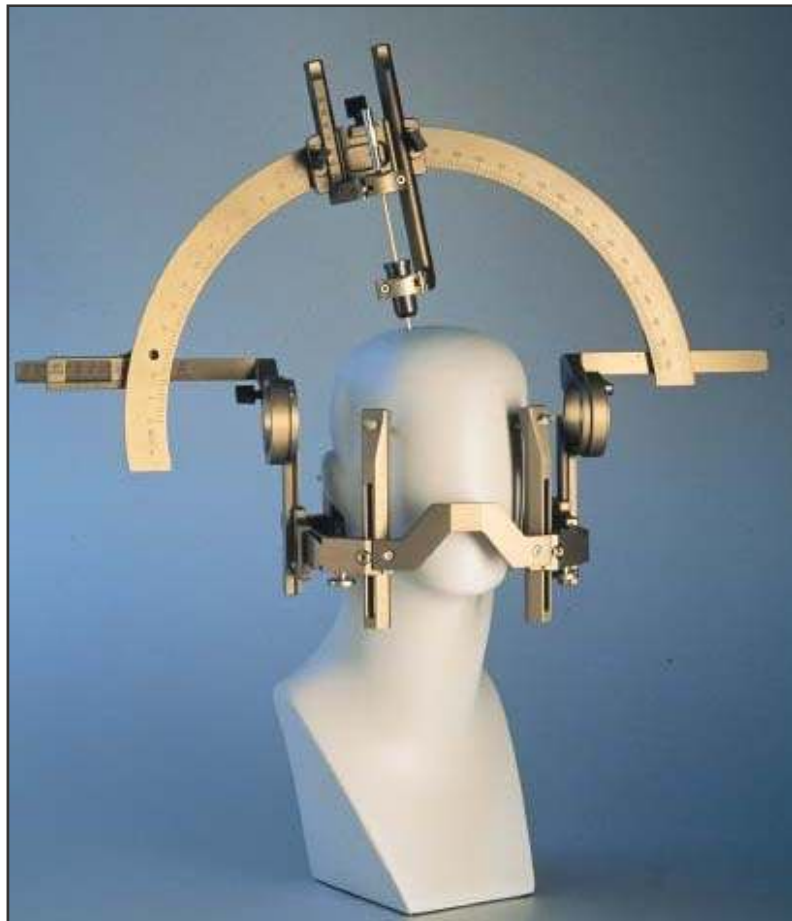
Targeting normal or pathological brain regions by using their 3D coordinates determined before with precise imaging techniques.

Tool:

Stereotaxic targeting instrument



Leksell stereotaxic instrument



Application fields of the stereotaxis

Parkinson's disease and other movement disorders

Surgical treatment of epilepsy

Surgical treatment of pain

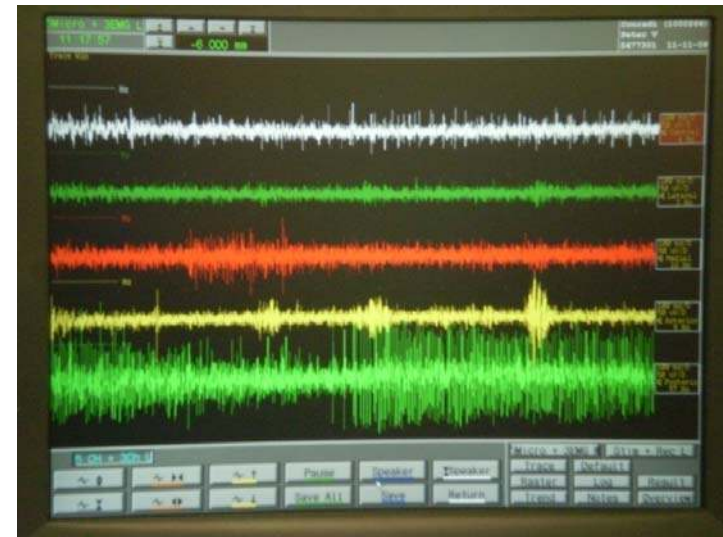
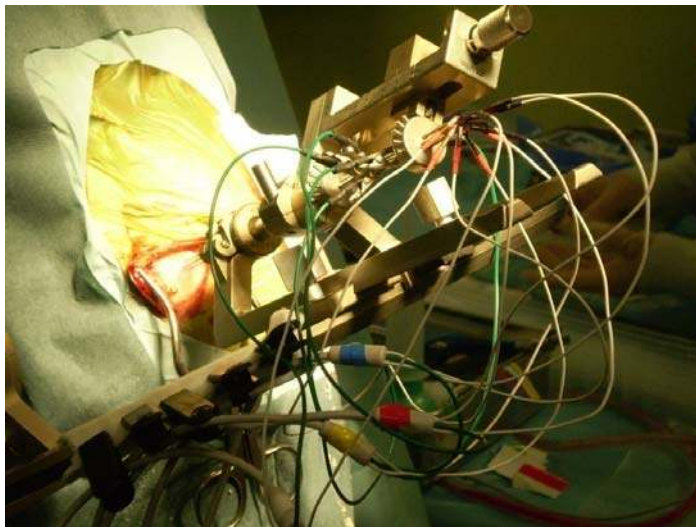
Treatment of abscesses, intracerebral haematoms, cysts,
tumors

Implantation of radioactive isotopes (e.g. Yttrium 90) into the
tumor

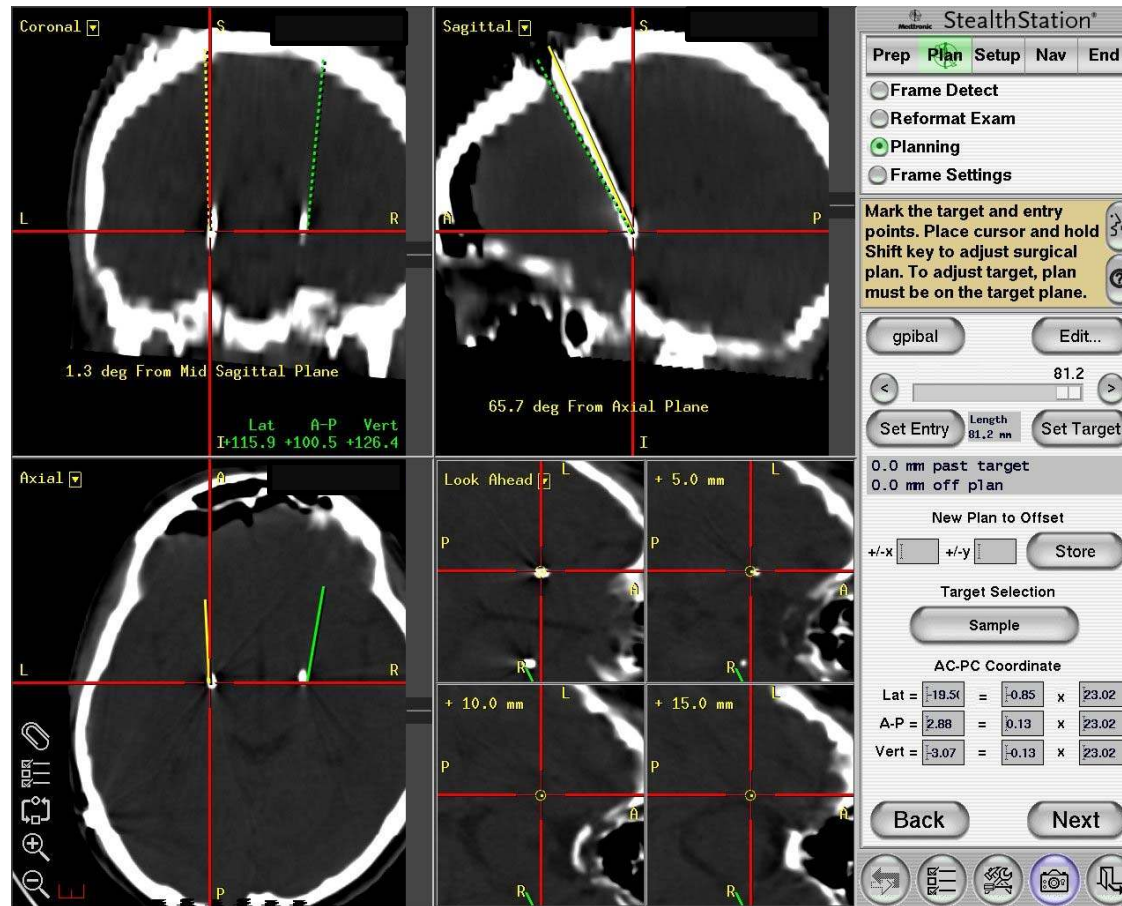
Application fields: Parkinson's disease

- Ablative surgical techniques
- **Stimulation techniques**
- Transplantation techniques

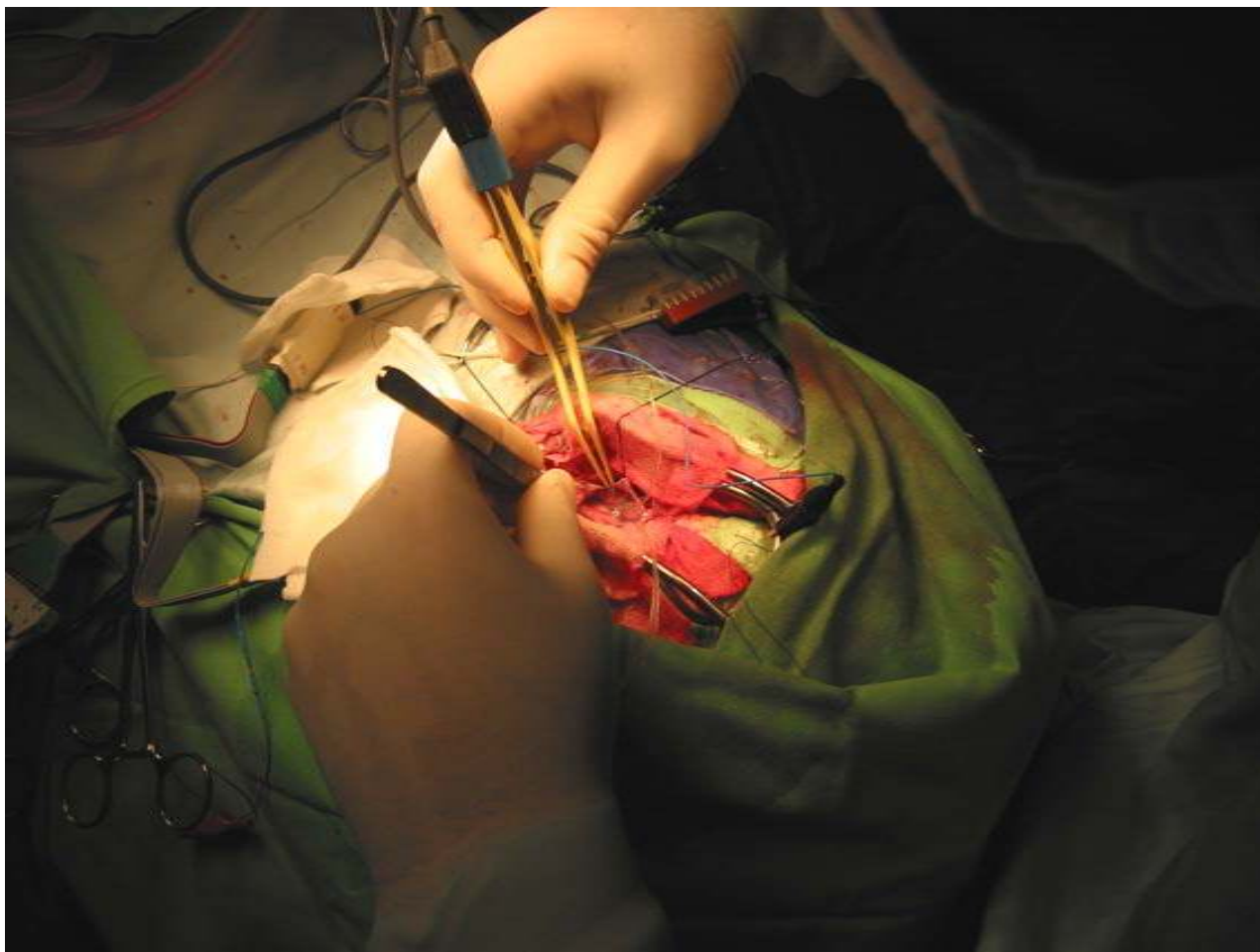
Intracerebral navigation with a microelectrode



Intracerebral navigation with a microelectrode ?



Surgical treatment of epilepsy



Probability of seizure in diagnosed epilepsy *(Brodie, Kwan NEJM 2000)*

Before the first drug treatment 64%

Before the second drug treatment 32%

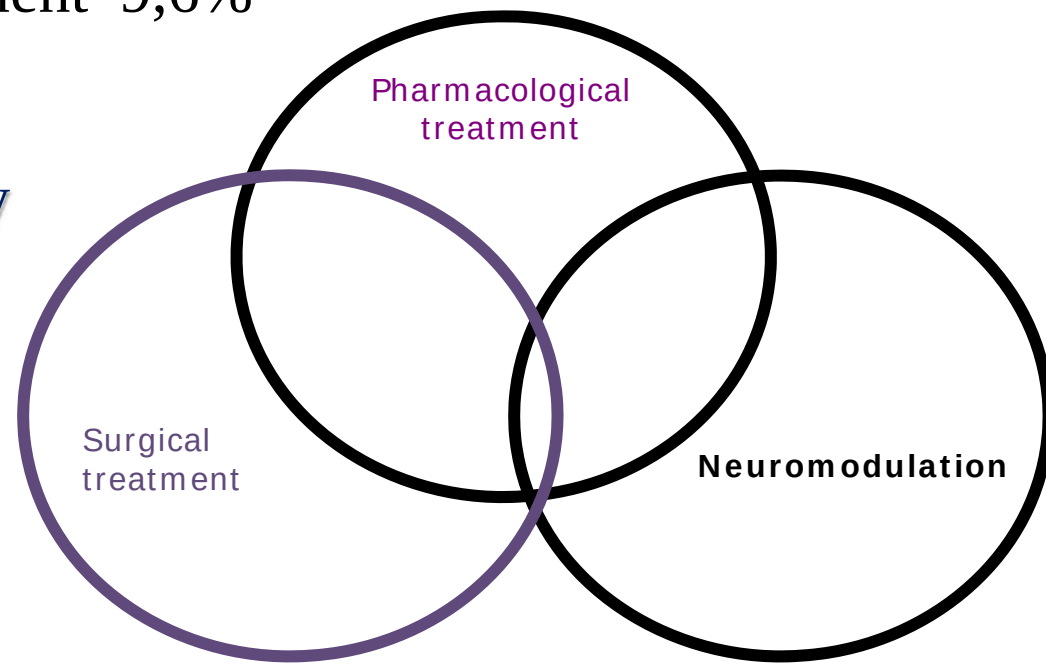
After the second drug treatment 9,6%

In case of politherapy 3%

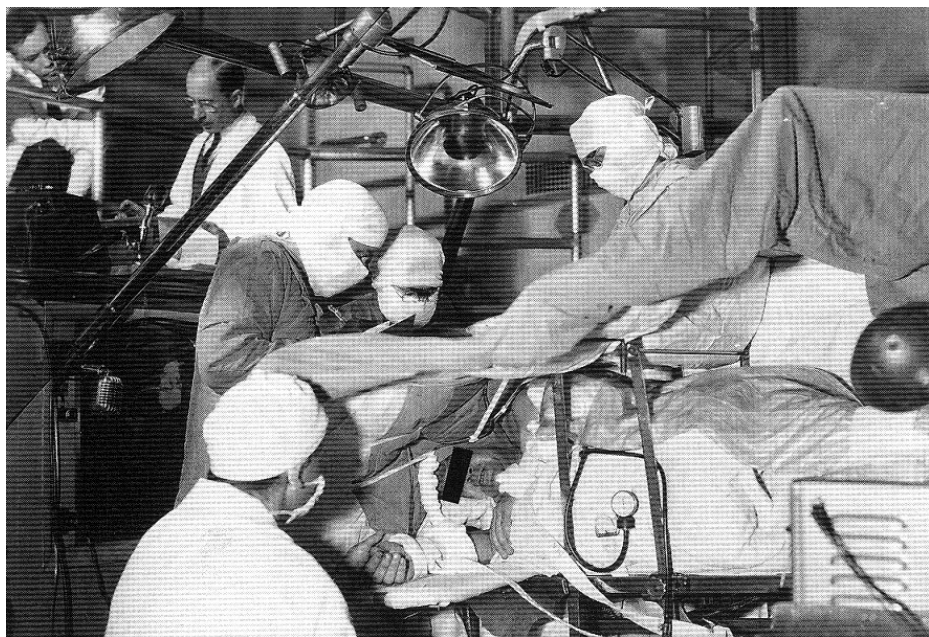
Surgical treatment of epilepsy

Aim:

To improve the psychosocial status of the patient by the abolishment of seizures or by reducing the number of seizures or by changing the semiology of the seizures.



Surgical treatment of epilepsy



Preoperative phase I.

- **Aim:** to set a hypothesis about the source of seizure
- Non-invasive phase:
- Search for lesion (MRI)
- Interictal and ictal EEG image
- Examining the functional state: building in interictal and ictal SPECT or maybe PET data
- Based on the convergence level of the data
 - lesionectomy
 - lesionectomy oriented by the epileptogenic zone
 - epilepsy surgery „sensu stricto,, (usually it requires further, invasive phase)

Preoperative phase II. invasive preoperative examinations

- Semi-invasive and invasive (subdural strip or grid, foramen ovale, or maybe intracerebral electrodes)
- Amytal test (dominant hemisphere, speech functions, memory)
- Decision: surgery? – what kind of surgery?

Surgery plan

- Aim:
Removal of the primary epileptogenic zone and/or the areas participating in the early spreading of the seizure, and the secondary „relay stations” e.g.: amygdalo- hippocampal complex without the deficit of eloquent brain regions
- Forms: „standard resectio”
„tailored surgery”

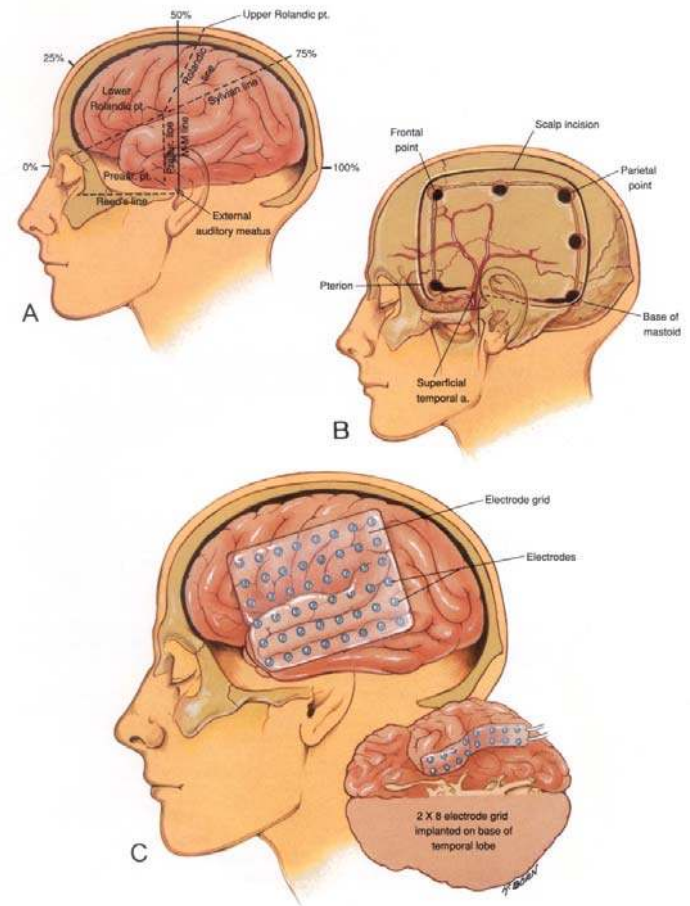
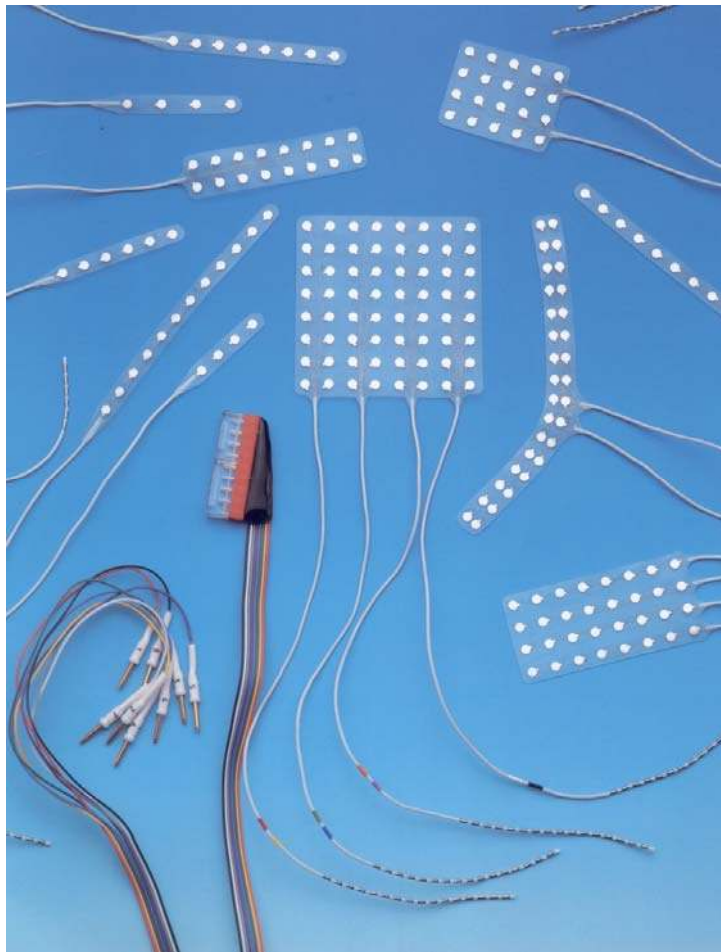
Aim of usage of invasive electrodes

3D spatial and temporal mapping of the site of origin and the spreading direction of epileptic seizures.

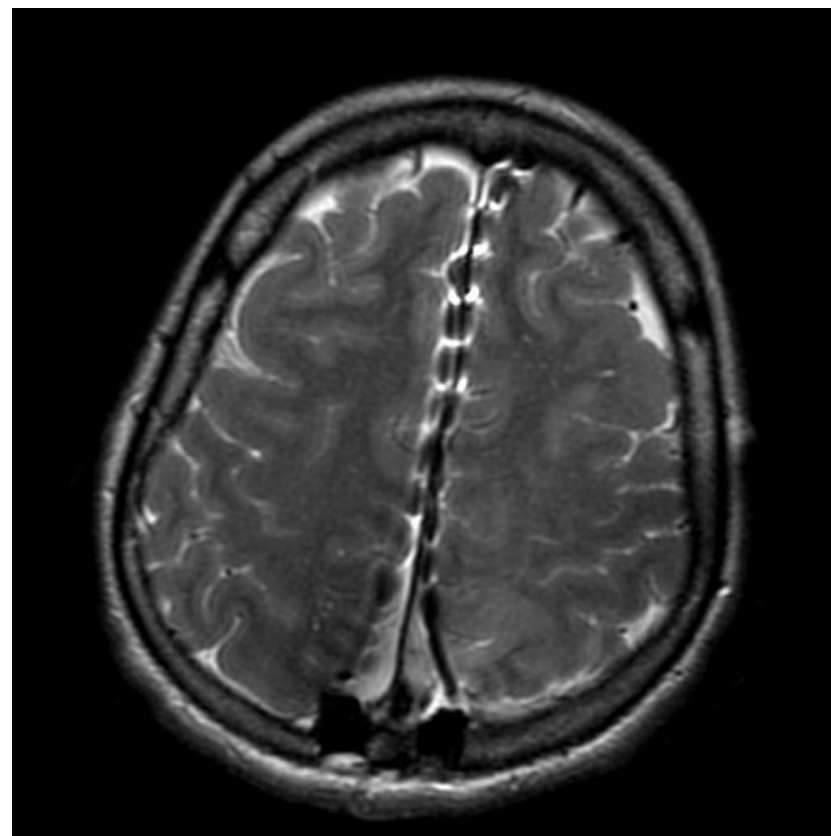
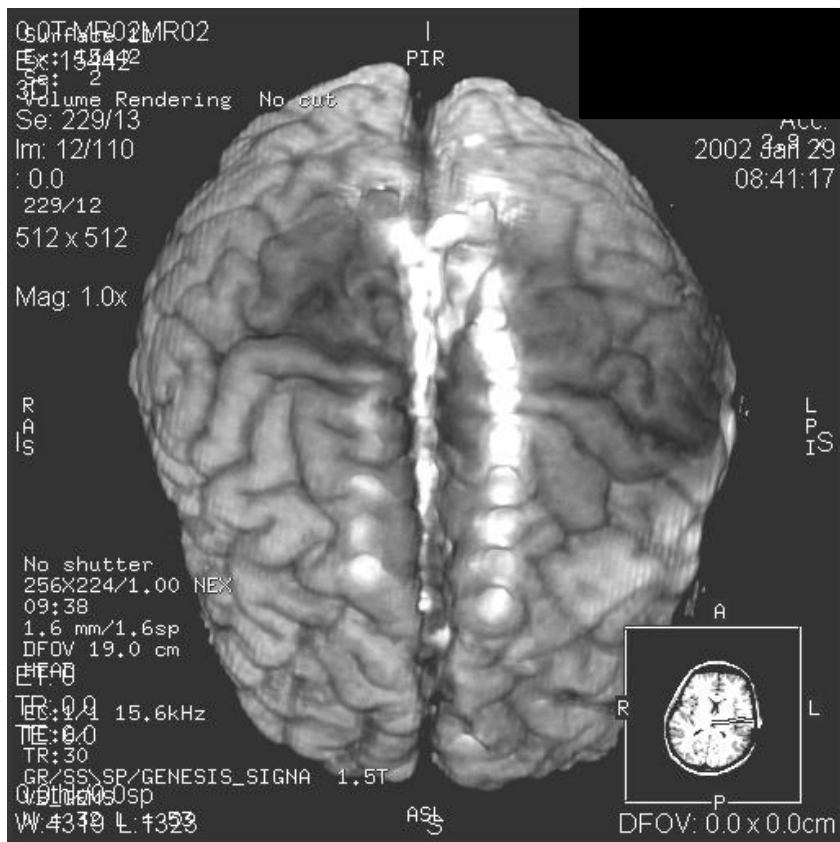
Semi-invasive and invasive electrodes

- Sphenoidal electrodes
- FO electrode
- Strips, grids
- PEG electrodes ??
- Intracerebral (makro- and microelektrodes)
- SEEG

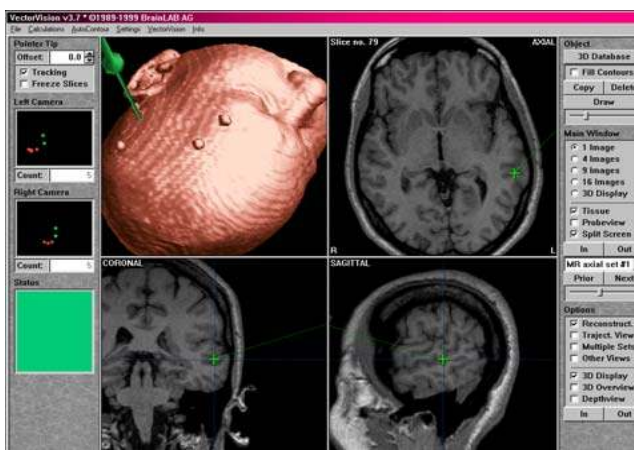
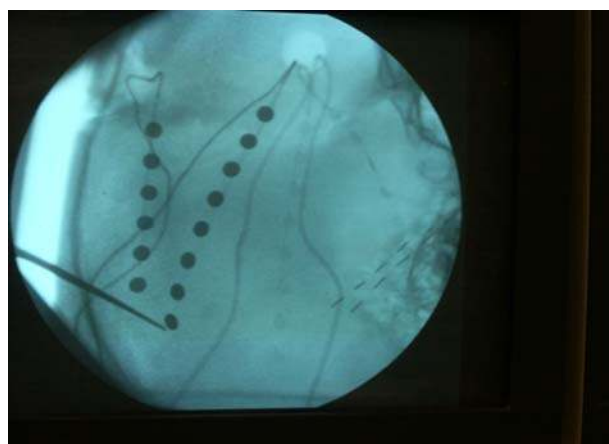
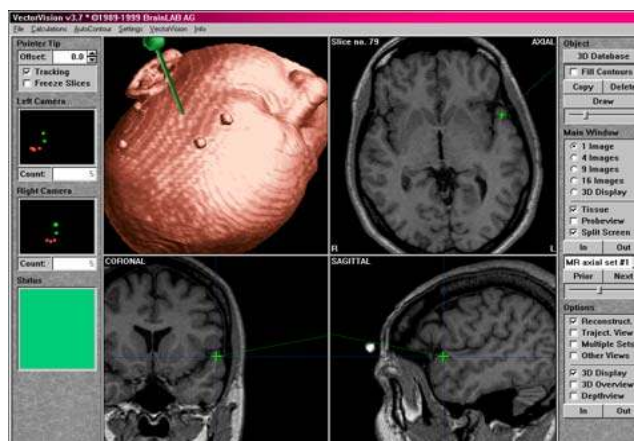
Invasive electrodes: strips, grids



Preoperative imaging – 3D reconstruction



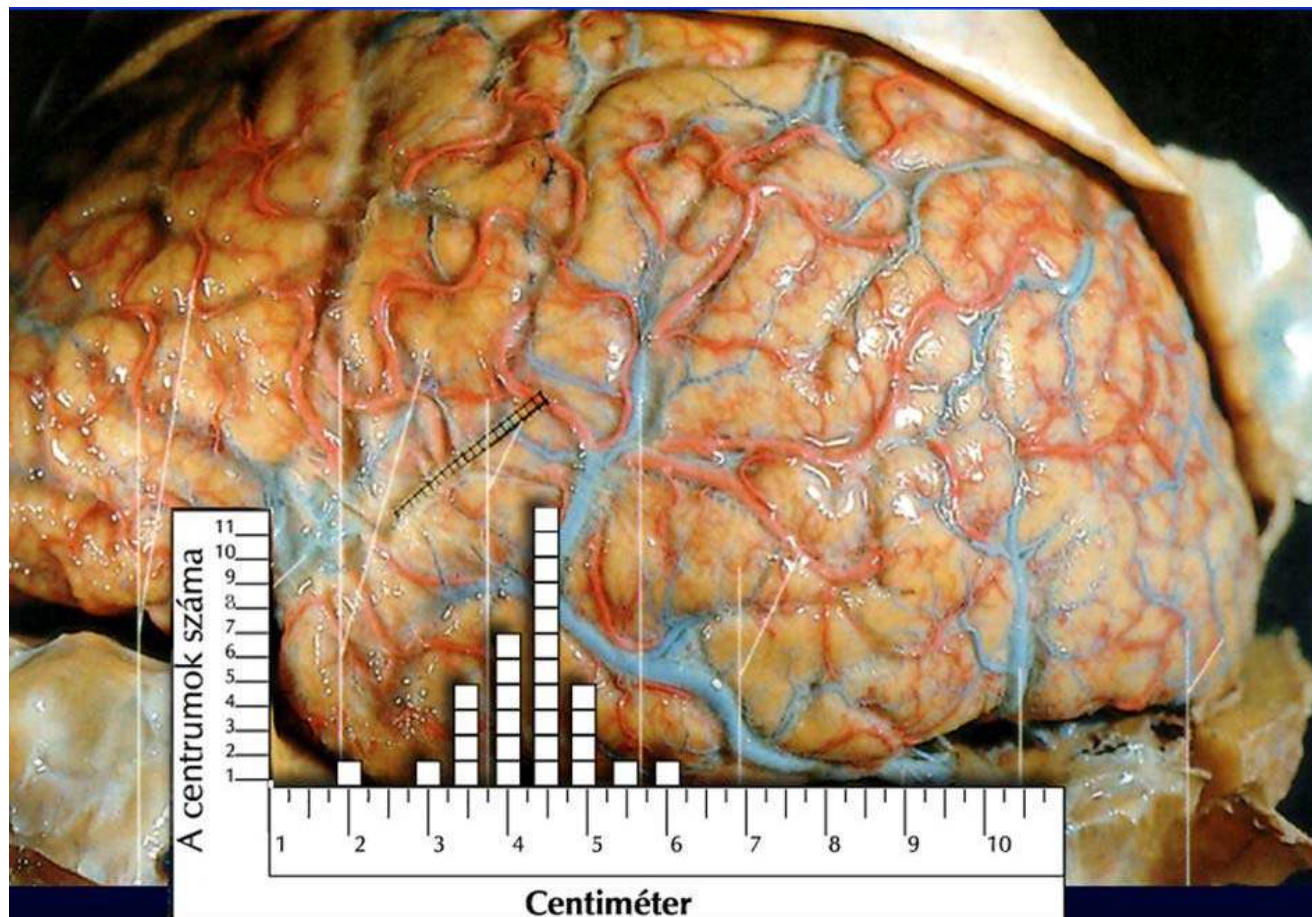
Neuronavigation-assisted electrode implantation



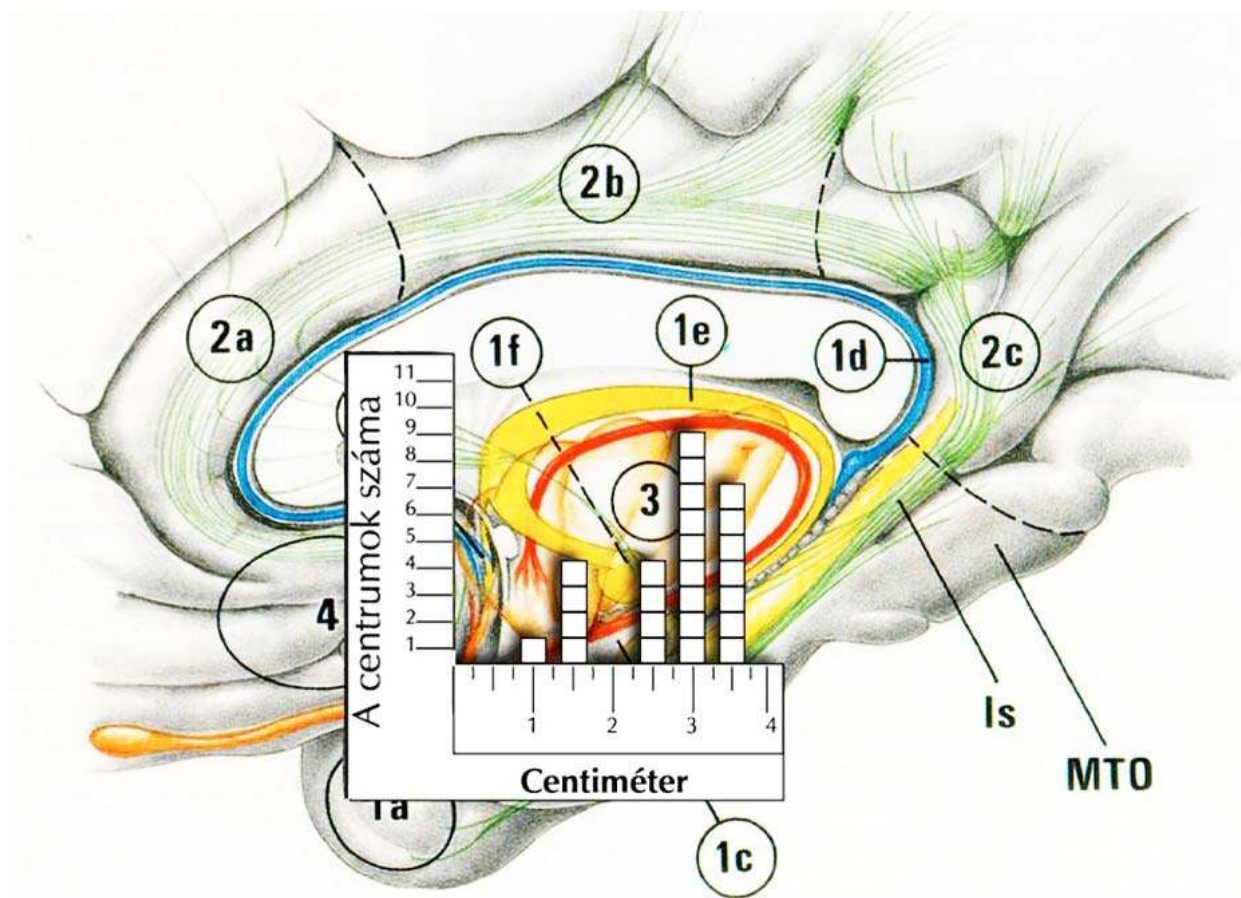
Intraoperative electrophysiology

- EcOG
- SSEP
- Electric cortical stimulation:
 - Epileptogenic zone
 - Speech mapping
 - Memory mapping
 - Motor cortex mapping

The extent of lateral resection in the dominant hemisphere



The extent of hippocampal and parahippocampal resection



Morell's subpial transection in the surgery of eloquent areas

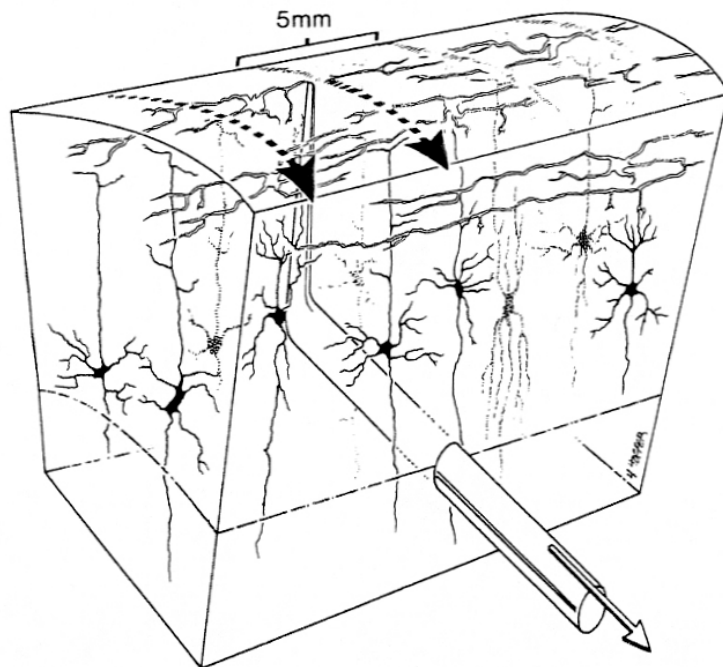


FIG. 3. Artist's drawing to illustrate the anatomical principles involved in multiple subpial transection.

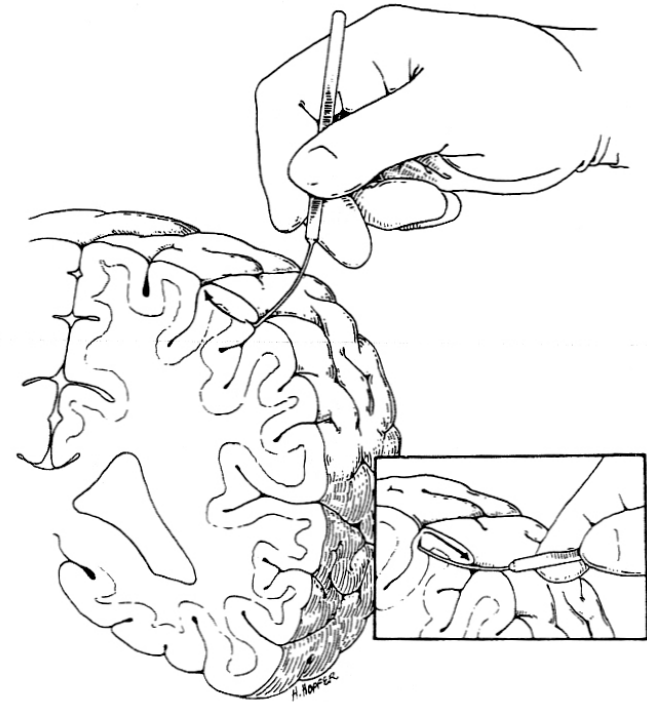


FIG. 2. Artist's drawing to illustrate the technique of insertion and movement of the subpial transector.

Alternative surgical techniques in epilepsy treatment

Stimulation of the vagus nerve:

in case of high frequency (50Hz) stimulation there is a 50% reduction of CPS in 35% of patients

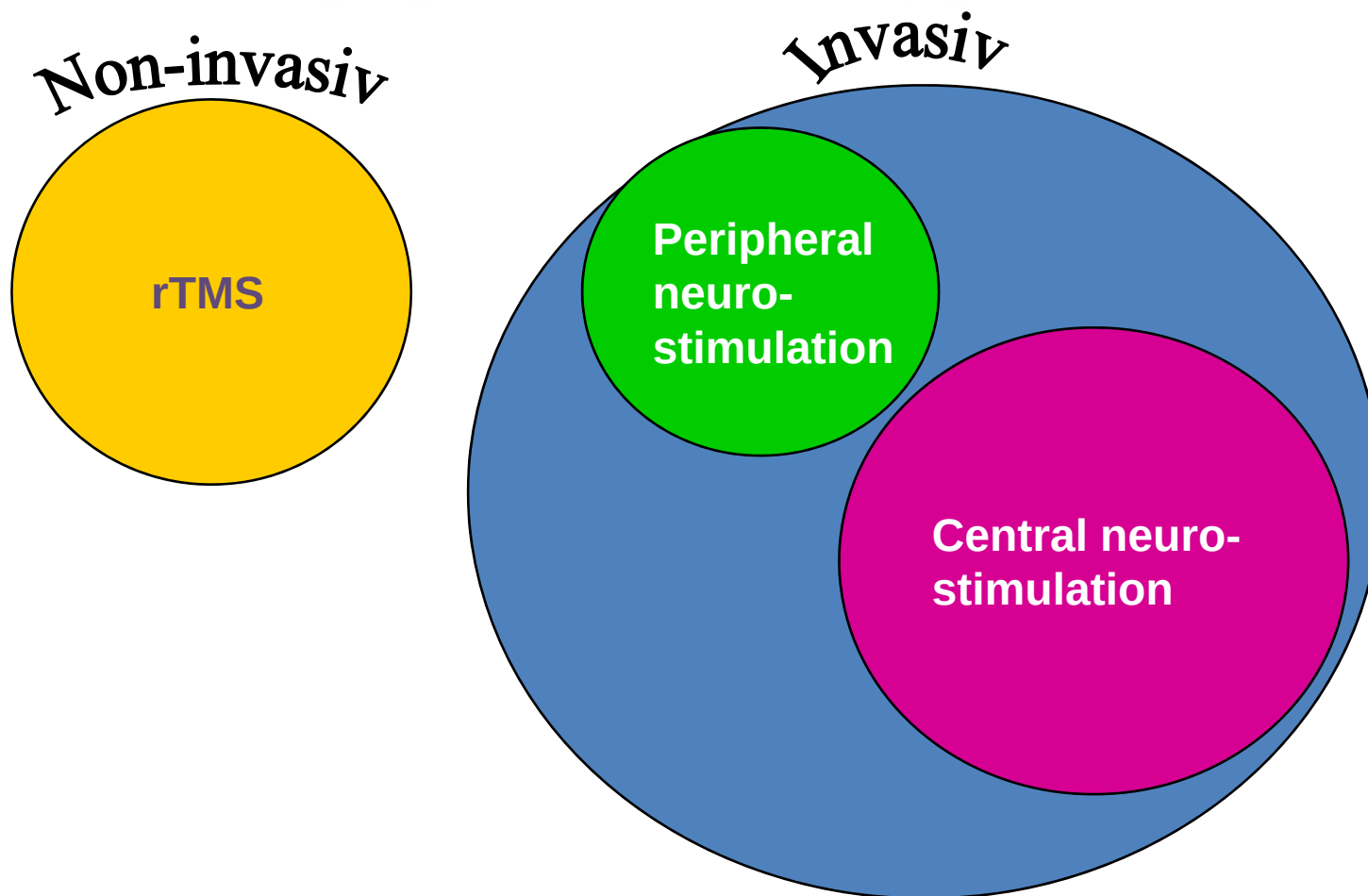
in case of low frequency (1-2Hz) stimulation there is an 80% reduction of CPS in 10% of patients

Stimulation of the right vagus nerve trigger more often bradycardia.

Stimulation of the CM nucleus of the thalamus:

there is no twofold blind prospective examination, the number of patients participating is low

Antiepileptic neuromodulatory procedures



Alternative surgical techniques in epilepsy treatment

Stimulation of the cerebellum:

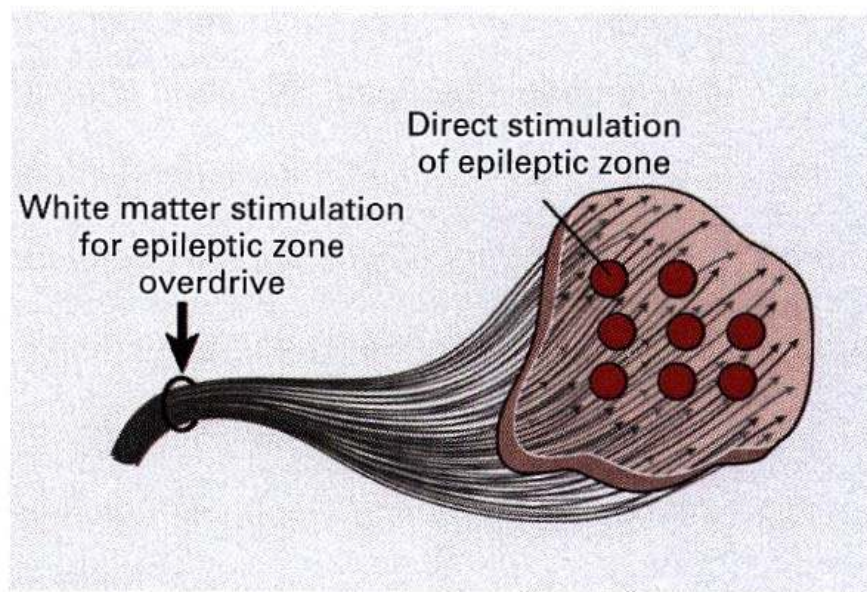
bilateral, extratemporal epilepsy, there is a 76% improvement, 27% of patients becomes seizure free, and 44% show reductions in the number of seizures

Stimulated region: vermis, interspherial surface

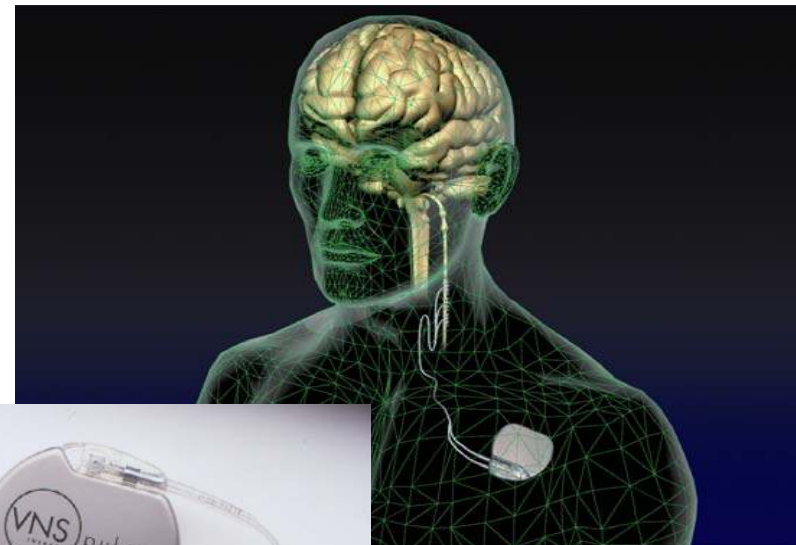
Stereotaxic amygdalotomy:

not used

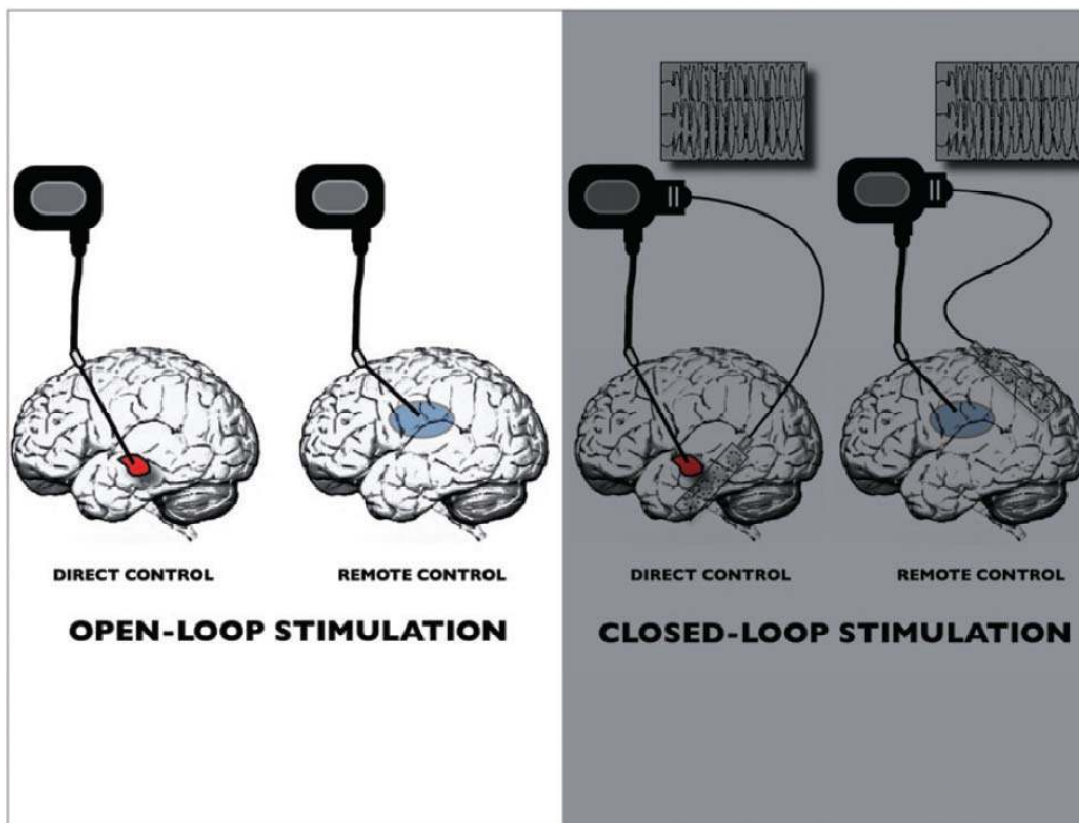
Stimulation of the white matter



Vagus Nerve Stimulation (VNS)



Cortical stimulation: open/closed loop techniques and local/remote approaches



*Nagel, Najm 2009
Neuromodulation*

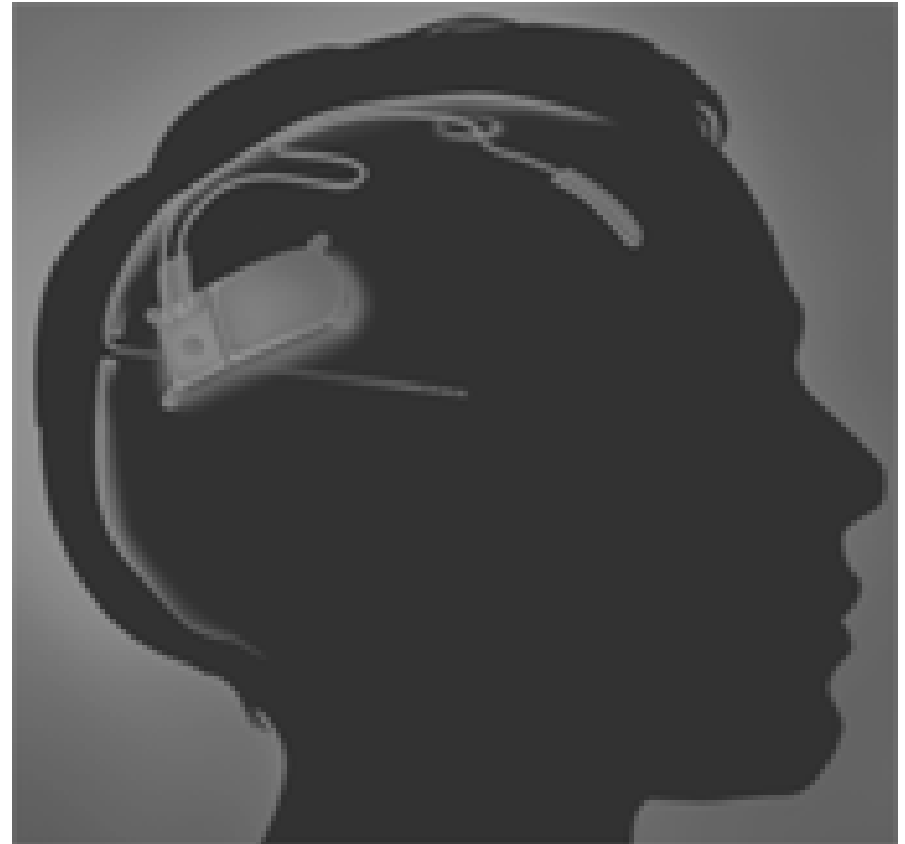
Cortical stimulation

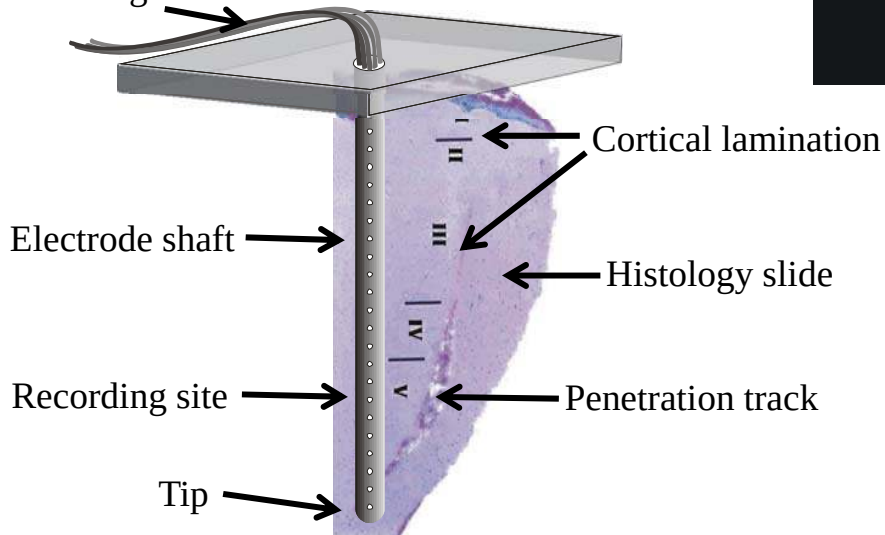
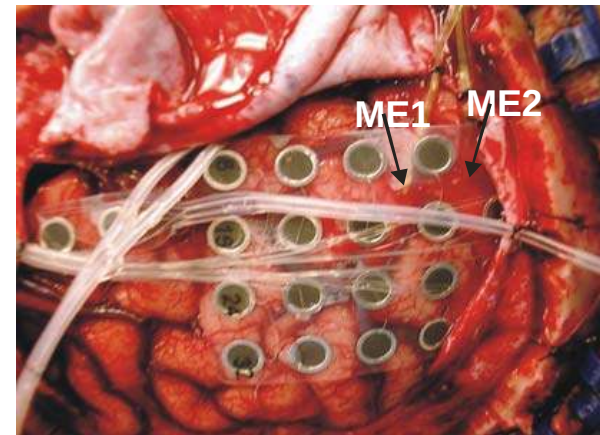
>100Hz, closed-loop

Direct focus stimulation,
preventing the seizure

RNS-Neuropace

- 45% reduction in the seizures





Epilepsy surgery – human experimental research

