Deep Brain Stimulation

- Parkinson’s disease
- Dystonia
- Nonparkinsonian tremor
- Other rare or less clarified indications

Surgical options

- Ablation
- Deep brain stimulation (DBS)
- Other less effective or ongoing research treatments
  - Gene therapy
  - Cell transplantation
  - Intracranial GDNF infusion
  - Motor cortex stimulation

Ablation
- Thalamotomy
- Pallidotomy

DBS vs Ablation

DBS
- Permit bilateral procedure
- Reversible
- Postop management
- Device related complications

HIGH COST
**Deep Brain Stimulation (DBS)**

Stimulation by frequency higher than neuronal firing will give suppression effect, not stimulation

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**1. Parkinson’s Disease**

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**Long Term Complications of L-dopa**

- Motor fluctuation *
  1. Wearing-off phenomenon
  2. On-Off phenomenon

- Dyskinesias *
  1. Chorea
  2. Dystonia

- Mental status changes
  1. Confusion
  2. Visual hallucinations
  3. Psychosis

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**Long-term Complications of L-dopa**

OFF time Parkinsonism

ON time Dyskinesia

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**History of treatment**

Before 1950s- no effective treatments

1950s- Thalamotomy era

1960s- L-dopa era, end of surgery

1990s- witness long term complication of L-dopa, resurgence of surgery: pallidotomy

2000s- Subthalamic nucleus stimulation

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**Rating model of PD**


excitation

inhibition
Bilateral Subthalamic DBS

- Target: dorsolateral STN
- All cardinal features of PD
- "Off" UPDRS improve 60%
- Increase "on" time 6 hours
- Reduce medication required
- Reduce dyskinesia 74% by decreased medication

Stim OFF
Stim ON

Siriraj long-term STN outcomes

- Improved "Off" time motor score 60%
- 33% medication reduction
- 13% of cases could stop all medication


Class 1

Bilateral Deep Brain Stimulation vs Best Medical Therapy for Patients With Advanced Parkinson Disease
A Randomized Controlled Trial

In this randomized controlled trial of patients with advanced PD, deep brain stimulation was more effective than best medical therapy in improving on time without troubling dyskinesias, motor function, and quality of life at 6 months, but


Class 1

Neurostimulation for Parkinson's Disease with Early Motor Complications

CONCLUSIONS
Subthalamic stimulation was superior to medical therapy in patients with Parkinson's disease and early motor complications. (Funded by the German Ministry of Research and others; EARLYSTIM ClinicalTrials.gov number, NCT00354133.)
Results at 5 years

PPN - future target for gait and posture?

25 Hz PPN-DBS for gait disturbance

preop postop

Dystonia

DBS for Dystonia

- General or segmental dystonia
- Selected cases of focal dystonia
  - Cranio-cervical dystonia (Meige synd)
  - Complex cervical dystonia
  - Task-specific focal hand dystonia

Surgery for dystonia

- Target: uncertain, recently V0 may better than GPI for STN may be combined with GPi
- Many reports show impressive results, surgery in patients with primary dystonia, especially DYR
- Surgical outcomes in secondary dystonia are more variable and less conclusive than primary dystonia
- In contrast with PD, no challenge test for dystonia to predict surgical outcomes
NonDYT-1 Primary General Dystonia

Delay & gradual improvement

Class 1
DBS for Primary General Dystonia

Randomized controlled trial of DBS vs. sham stimulation for primary dystonia

*Improvement 40% in stimulation group vs 5% in sham-stimulation group


DBS for Primary General Dystonia

French multicentre trial of DBS for primary general dystonia showed improvement of 51% at 1 year. One third of patients improved more than 75%. (N=22)


The improvement in this cohort maintained in 3 years follow-up.
Lancet Neurol., 2007; 6:223-229

Sriraj Outcomes of Primary dystonia

» Mean improvement of BFMDRS 71%

» Cranio-cervical symptom, such as facial contraction, spasmodic dysphonia, and laryngopharyngeal dystonia, which were not improve in PD, improved very well in dystonia.

» Mobile type and segmental type got the fastest improvement and the best outcomes

Cranio-cervical dystonia
Mobile dystonia
Fast improvement

preop
1 day
postop

Mobile dystonia
Fast improvement

preop
A few days
postop

Mobile dystonia
Fast improvement

preop
1 day
postop

Cerebral Palsy
There were reports of dystonic CP could improve by pallidotomy

preop
postop

3 of 4 cases of secondary dystonia from cerebral palsy failed to improve

Bruton agammaglobulinemia
Sriraj outcomes of Secondary dystonia

- Various response.
- Mean Improvement of BFMDRS 30%
- DBS was much better than pallidotomy

; need a larger pallidotomy than for P.D.??

Possible predictive factors

- Primary segmental 82%
- Primary mobile 75%
- Primary general 20%
- Tardive 97%
- Dominant bulbar symptom

GOOD
- Hallervorden-Spatz
- Stroke 100%
- Traumatic 47%
- Hemidystonia

MAY BE GOOD
- Infection 0%
- Huntington 0%
- CP 0%

POOR

3. Tremor

Resting tremor
Postural tremor
Intention tremor

Surgery for Tremor

- Target: Vim (Vop and occasionally)
- Thalamic procedures appear to work best, resting tremor > postural tremor, distal limb tremor > proximal limb tremor
- (some suggest to target Vop and taget Zi for proximal limb tremor)
- Thalamic surgery makes immediate improvement in contralateral tremor

Thalamic surgery makes immediate tremor improvement
DBS for essential tremor
Multicentre European study
: sustained improvement after 6 years

J Neurol Neurosurg Psychiatry. 2003;74:1387-1391

Essential tremor

5. Rare or unclarified indications

› Hemiballism
› Tourette syndrome
› Tardive disorders
› Chorea
› etc

Hemiballism

Made by Mahidol University

1 DBS = 860,000 Bath !!
Average Thai income = 150,000 Bath/ year
impossible for most patients
Other Neuromodulations

- Major depression
- Obsessive compulsive disorder
- Tourette syndrome
- Epilepsy
- Minimally conscious state
- Obesity
- Cluster headache
- Chronic pain
- Central apnea

Novel Technologies

- "Smart" Systems for On-Demand Pacing
  - Medically-refractory epilepsy
  - Implantation of depth & cortical electrodes
  - Detects abnormal brain activity
  - Responds by delivering stimulation prior to seizure
  - Multi-center, FDA-approved, industry-sponsored

- Such a closed-loop stimulation may
  - Improve results by delivering therapy only when needed
  - Decrease demands on stimulation systems
  - Q: Development of seizure prediction algorithms?
  - Q: Intervene with stimulation or drug \(\Rightarrow\) seizure aborted?

Phrenic Nerve Stimulation

Auditory Brainstem Implant