

OVERVIEW OF DEEP BRAIN STIMULATION (DBS), CURRENT INDICATIONS, PATIENT SELECTION, BASICS OF SURGERY

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Overview of DBS- historical background

- Early and more recent history
 - Gildenberg PL. History of Surgery for Movement Disorders. In: Bakay RAE (ed). Movement Disorder Surgery: The Essentials. Thieme Medical Publishers, 2009:1-11.
 - Benabid AL, Pollak P, Louveau A, Henry S, de Rougemont J. Combined (thalamotomy and stimulation) stereotactic surgery of the VIM thalamic nucleus for bilateral Parkinson disease. Appl Neurophysiol 1987;50(1-6):344-6.
 - Hariz MI, Blomstedt P, Zrinzo L. Deep brain stimulation between 1947 and 1987: the untold story. Neurosurg Focus 2010;29(2):1-10.
 - Miciocinovic S, Somayajula S, Chitnis S, Vitek JL. History, Applications, and Mechanisms of Deep Brain Stimulation. JAMA Neurol 2013;70(2):163-171.

Current FDA approved Movement Disorder Indications

- Essential Tremor:
 - 1997: Tremor in the upper extremity in patients diagnosed with essential tremor or parkinsonian tremor not adequately controlled by medications and where tremor constitutes a significant functional disability
 - Unilateral VIM DBS
- Parkinson's disease:
 - 2002: As an adjunctive therapy in reducing some of the symptoms of advanced, levodopa-responsive Parkinson's disease that are not adequately controlled with medication
 - 2016: PD of at least 4 years duration and with recent onset of motor complications or motor complications of longer-standing duration that are not adequately controlled with medications
 - Bilateral STN DBS
 - Bilateral GPI DBS
- Primary Dystonia (HDE)
 - 2003: Aid in the management of chronic, intractable (drug refractory) primary dystonia, including generalized and segmental dystonia, hemidystonia, and cervical dystonia (torticollis) in patients seven years of age or older.
 - Unilateral or Bilateral GPI DBS
 - Unilateral or Bilateral STN DBS

Evidence for efficacy of bilateral DBS: RCTs

- Parkinson's disease
 - Deuschl G et al. A Randomized Trial of Deep-Brain Stimulation for Parkinson's disease. N Engl J Med 2006;355:896-908.
 - Williams A et al. Deep brain stimulation plus best medical therapy versus best medical therapy alone for advanced Parkinson's disease (PD SURG trial): a randomized, open-label trial. Lancet Neurol. 2010;9:581-591.
 - Schuepbach WMM et al. Neurostimulation for Parkinson's disease with Early Motor Complications N Engl J Med 2013;368:610-22.
 - Weaver FM et al. Bilateral deep brain stimulation vs best medical therapy for patients with advanced Parkinson's disease: a randomized controlled trial. JAMA 2009;301:63-73.

- Follett KA et al. Pallidal versus Subthalamic Deep Brain Stimulation for Parkinson's disease. *N Engl J Med* 2010;362:2077-2091.
- Odekerken VJJ et al. Subthalamic nucleus versus globus pallidus bilateral deep brain stimulation for advanced Parkinson's disease (NSTAPS study): a randomised controlled trial. *Lancet Neurol* 2013;12(1):37-44.
- Essential tremor
 - Schuurman PR et al. A comparison of continuous thalamic stimulation and thalamotomy for suppression of severe tremor. *N Engl J Med* 2000;342(7):461-8.
- Dystonia
 - Vidailhet M et al. Bilateral deep-brain stimulation of the globus pallidus in primary generalized dystonia. *N Engl J Med* 2005;352:459-467.
 - Kupsch A et al. Pallidal deep-brain stimulation in primary generalized or segmental dystonia. *N Engl J Med* 2006; 355:1978-90.

Patient Selection

- General considerations
 - Coleman RR and Ostrem JL. Patient selection: When to consider DBS for patients with Parkinson's disease, Essential tremor, or Dystonia. in : Marks W (ed). *Deep Brain Stimulation Management*. Cambridge University Press; 2015:5-30.
 - Verhagen Metman L. Selection of Centers, Disorders and Patients for Movement Disorder Surgery. In: Bakay RAE (ed). *Movement Disorder Surgery*, Thieme Medical Publishers, 2009:48-57.
- Parkinson's disease specific considerations
 - Levodopa OFF/ON evaluation
 - Defer GL, Widner H, Marie RM, Remy P, Levivier M. Core assessment program for surgical interventional therapies in Parkinson's disease (CAPSIT PD). *Mov Disord* 1999;14:572-84
 - Predictors of good response to DBS
 - Charles PD, Van Blercom N, Krack P et al. Predictors of effective bilateral subthalamic nucleus stimulation for PD. *Neurology* 2002;59:932-4.
 - Welter M, Houeto J, Tezenas du montcel S, et al. Clinical predictive factors of subthalamic stimulation in Parkinson's disease. *Brain* 2002;125:575-83.
 - When becomes DBS an option? Therapeutic window.
 - Schuepbach WMM et al. Neurostimulation for Parkinson's disease with Early Motor Complications *N Engl J Med* 2013;368:610-22.
 - Patient expectations.
 - Coleman RR and Ostrem JL. Patient selection: When to consider DBS for patients with Parkinson's disease, Essential tremor, or Dystonia. in : Marks W (ed). *Deep Brain Stimulation Management*. Cambridge University Press; 2015:5-30.
- Essential tremor and Dystonia
 - Selection criteria
 - Coleman RR and Ostrem JL. Patient selection: When to consider DBS for patients with Parkinson's disease, Essential tremor, or Dystonia. in : Marks W (ed). *Deep Brain Stimulation Management*. Cambridge University Press; 2015:5-30.
 - Predictors of good response to DBS
 - Verhagen Metman L. Selection of Centers, Disorders and Patients for Movement Disorder Surgery. In: Bakay RAE (ed). *Movement Disorder Surgery*, Thieme Medical Publishers, 2009:48-57.

DBS procedure

- Stereotactic frame, trajectory/navigation, electrophysiology
 - Alterman RL, Tagliati M. Preparation for surgery. In: Bakay RAE (ed): Movement Disorder Surgery: The Essentials. Thieme Medical Publishers, 2009:58-69.
 - Bronte-Stewart H. Surgical placement of deep brain stimulation leads for the treatment of movement disorders: intraoperative aspects: physiological mapping, test stimulation, and patient evaluation. in: Marks W (ed). Deep Brain Stimulation Management. Cambridge University Press; 2015:31-42.
- Components of the DBS system
 - Internal
 - Intracerebral DBS lead; Lead extensions; Pulse generators
 - External
 - Clinician programmer; Patient programmer
- New ways to perform DBS
 - Intra-operative MRI
 - Larson PS, Starr PA, Bates G, Tansey L, Richardson RM, Martin AJ. An optimized system for interventional MRI guided stereotactic surgery: preliminary evaluation of targeting accuracy. Neurosurgery. 2012 Mar;70(OPERATIVE):ons95.
 - Intra-operative CT
 - Mirzadeh Z, Chapple K, Lambert M, Dhall R, Ponce FA. Validation of CT-MRI fusion for intraoperative assessment of stereotactic accuracy in DBS surgery. Mov Disord. 2014 Dec;29(14):1788-95.
 - Bot M, van den Munckhof P, Bakay R, Stebbins G, Verhagen Metman L. Accuracy of intraoperative CT during DBS procedures: comparison with postoperative MRI. Stereotact Funct Neurosurg, in press
- Novel DBS systems
 - Current shaping
 - Current steering