

MD-1. An Unilateral Tunneling Technique for the Implantation of Bilateral Neurostimulators in Deep Brain Stimulation Surgery

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Objective: We introduce an alternative surgical technique using an unilateral tunneling technique through subcutaneous tissue from the head to the chest for the implantation of bilateral neurostimulators in the chest in the deep brain stimulation (DBS) surgery.

Methods: The procedure was performed under general anesthesia using subcutaneously left-sided tunnel from the posterior parietal area to left neurostimulator pocket: A distal connector wire was passed subcutaneously from right-sided pocket to left-sided pocket, a groove was made on left posterior parietal bone after a linear skin incision for implanting the connector of DBS system, and two connectors and extensions of DBS hardware system were passed together. The unilateral tunneling technique (15 patients using 30 neurostimulators) were compared with the standard bilateral tunneling technique (50 patients using 100 neurostimulators).

Results: The mean operation time was 113.7 ± 14.5 minutes for the unilateral tunneling technique and 151.7 ± 22.5 minutes for the bilateral tunneling technique. This difference was statistically significant ($p < 0.05$). The need for repreparing and redraping was eliminated in the unilateral tunneling technique. Implanted hardware system showed cosmetically acceptable in two techniques. No hardware-related complications, such as skin erosion and migration, occurred with the unilateral tunneling technique for more than 12 months of follow-up.

Conclusion: The unilateral tunneling technique provides a reliable alternative for the bilateral tunneling technique in the implantation of each neurostimulator in both sides of chest during DBS surgery.

MEMO



MD-2. Bilateral Deep Brain Stimulation of the Subthalamic Nucleus Under Sedation with Propofol and Fentanyl

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Backgrounds: Awakening during deep brain stimulation (DBS) surgery is very stressful to patients.

Objective: The aim of the current study was to evaluate the effect on MER signals and their applicability to subthalamic nucleus (STN) DBS surgery for patients with Parkinson's disease (PD) under general anesthesia with propofol and fentanyl.

Methods: Seventeen consecutive patients with PD underwent STN-DBS surgery with propofol and fentanyl under general anesthesia. Their MER signals were achieved during the surgery. To identify the microelectrodes positions, the preoperative MRI and postoperative CT were used. Clinical profiles were also collected at the baseline and at 6 month after surgery.

Results: The firing rates of MER signals did not show any differences between both sides. All that signals were slightly attenuated and contained only bursting patterns, compared with our previous report. All electrodes were mostly located in the middle one third part of the STN on both sides of the brain in the fused images. Six months later, the patients were improved significantly in the medication-off state and they met with less dyskinesia and less off-duration.

Conclusion: Our study revealed that the general anesthesia with propofol and fentanyl was applicable to STN-DBS surgery. There were no significant problems in precise positioning of bilateral electrodes. The surgery also improved significantly clinical outcomes in 6-month follow up.

MEMO



MD-3. Patients' Reluctance to Undergo Deep Brain Stimulation for Parkinson's Disease

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Objective: Many patients with advanced Parkinson's disease (PD) are reluctant to undergo the subthalamic nucleus deep brain stimulation (STN-DBS) when surgery is warranted. Reasons for this reluctance have not been examined. We undertook to establish the rate and causes of this reluctance for STNDBS in patients with advanced PD.

Methods: A reluctant group was defined as patients who were hesitant to undergo DBS. Clinical information included age, onset age, disease duration, the Unified Parkinson Disease Rating Scale, Hoehn and Yahr stage and levodopa equivalent dose when they were evaluated with a view to consider surgery.

Results: We enrolled 186 patients who underwent STN-DBS. 84 patients (45%) belonged to the reluctant group. Between the reluctant and the non-reluctant, there were no differences in preoperative characteristics. Main reasons for hesitation were fear of complications (74%) and economic burden (50%). The main reasons that they finally underwent the DBS were confidence in the doctor's decision (80%) and encouragement from their family (36%).

Conclusion: Building trust between patients and physicians is an important factor in guiding patients to undergo this treatment. To reduce the reluctance to undergo DBS at the appropriate time, we need to find effective ways of reducing their psychological and economic burden.

MEMO



MD-4. Improvement of Levodopa Induced Dyskinesia by Interleaving Stimulation in Subthalamic Nucleus Area

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Objective: Although both subthalamic nucleus (STN) and globus pallidus interna (GPi) stimulation are effective to reduce levodopa-induced dyskinesia (LID) in patients with Parkinson's disease (PD), STN stimulation is regarded to decrease LID by reducing dopaminergic medication, while GPi stimulation has direct anti-dyskinetic effects.

Methods: In the three PD patients who could not tolerate optimal dose of levodopa agonists due to LID with low threshold, STN DBS were performed and interleaving stimulation (stimulation of both ventral and dorsal contacts with different parameters) was tried.

Results: After interleaving stimulation, abnormal involuntary movement score was reduced from 15.0 to 3.3, meanwhile dopaminergic medications were increased from 616.7 mg to 833.3 mg in levodopa equivalent daily dose. Dorsal contacts were estimated to be located at pallidofugal fibers and ventral oralis anterior nucleus of thalamus.

Conclusion: Both parkinsonism and LID could be controlled successfully with interleaving stimulation of both STN and Zi area not only from reduction of medication but also from direct antidyskinetic effect of stimulation.

MEMO



MD-5. Different Clinical Course of Pallidal Deep Brain Stimulation for Phasic- and Tonic-Type Cervical Dystonia

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Objective: Dystonia has been treated well using deep brain stimulation at the globus pallidus internus (GPi DBS). Dystonia can be categorized as two basic types of movement, phasic-type and tonic-type. Cervical dystonia is the most common type of focal dystonia, and sequential differences in clinical outcomes between phasic-type and tonic-type cervical dystonia have not been reported.

Methods: This study included a retrospective cohort of 30 patients with primary cervical dystonia who underwent GPi DBS. Age, disease duration, dystonia direction, movement types, employment status, relevant life events, and neuropsychological examinations were analyzed with respect to clinical outcomes following GPi DBS.

Results: The only significant factor affecting clinical outcomes was movement type (phasic or tonic). Sequential changes in clinical outcomes showed significant differences between phasic- and tonic-type cervical dystonia. A delayed benefit was found in both phasic- and tonic-type dystonia.

Conclusion: The clinical outcome of phasic-type cervical dystonia is more favorable than that of tonic-type cervical dystonia following GPi DBS.

MEMO



MD-6. Estimating Spatial Errors of Brain MRI for Stereotactic Procedures with Multiple Encoding Directions

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Background: Deep brain stimulation (DBS) now is popular for the treatment in various diseases. The key of image-guided surgery like DBS is the accuracy and reliability of targeting throughout the procedures.

Objective: To investigate the presence and range of magnetic resonance image (MRI) distortion according to the encoding direction during image acquisition.

Methods: Each T2-weighted image (T2WI) and T1WI were acquired in both encoding direction of Right-to-Left (RL) and Anterior-to-Posterior (AP) in their pre-operative 1.5-tesla (T) MRI imaging. The images were then co-registered with thin-sliced brain computed tomography (CT) images with Surgiplan software (Elekta AB, Sweden). Target coordinates of various structures which are clearly visible on CT were compared and analyzed.

Results: Twenty patients underwent DBS from September 2015 to February 2016 were enrolled. In all cases the direction of error was unique according to the combination of the images. The range of errors was much larger in targets located far from the center of the images than those in the center of the images. The images of RL-directed sequence showed much error in X-axis, whereas the AP-directed sequence had much Y-axis errors.

Conclusion: Spatial error which may influence the target coordinates in stereotactic neurosurgical procedures in brain MRI differs according to the encoding direction. Consideration about frequency encoding direction is essential for determining accurate target coordinates.

MEMO



MD-7. Stereotactic Accuracy in Function or MRI-guided Deep Brain Stimulations

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Objective: We investigated stereotactic accuracy of deep brain stimulation surgeries in MRI-guided or function-guided surgical paradigms.

Methods: From June 2013 to Jan 2016, 93 deep brain stimulation surgeries with 172 leads were evaluated for stereotactic errors. Targets were subthalamic nucleus (STN, 139 leads) or globus pallidus interna (GPi, 33 leads). Target selections were based on either MRI only (MRI-guided group) or MRI-target adjusted with microelectrode recordings and intraoperative neurologic examinations (function group). Stereotactic errors of shifted-tracks were calculated using geometric methods.

Results: Functional evaluation tended to increase stereotactic errors in STN-function group (N=129, 1.4 ± 0.7 mm) than STN-MRI group (N=10, 1.0 ± 0.6 mm, $p=0.06$). Significantly higher stereotactic error leads (N=65, 1.6 ± 0.7 mm, $p < 0.001$ compared to the center-track selected leads, N=64, 1.2 ± 0.7 mm) were required to be track-shifted by intraoperative functional evaluation. Track-shifts significantly frequently occur (56 of 65 leads, 86%, $p < 0.000001$) toward MRI-targets compensating stereotactic error. After track-shifts, distances to MRI-targets were reduced (-0.4 mm, N=55, $p=0.013$, excluding the earliest 10 leads) as low as leads which does not need to be shifted. Total errors including both MRI-based targeting errors and stereotactic errors are estimated as 1.0 ± 0.1 mm based on that 51% of 2 mm track-shifts. Therefore, track-shifts and total errors are determined mainly by stereotactic errors. Thus, targeting errors are low.

GPi-MRI group had significantly lower stereotactic error (N=33, 0.9 ± 0.5 mm) than most STN groups. **Conclusion:** Low stereotactic and targeting errors shows why MRI-guided DBS is a possible option. Instead, function-guided DBS can highly selectively and accurately compensate high stereotactic errors finally as low as MRI-guided DBS.

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