Deep Brain Stimulation case series

2021

Feldmann et al. from the Charité-Berlin, retrospectively analyzed incidence and infection characteristics in adult patients who underwent two-staged DBS surgery with temporary externalization of leads between January 2008 and November 2019. They focused on whether patients had participated in local field potential (LFP) recordings, and evaluated incidence of infections at 3 months and 1 year after the surgery based on medical records. Infection rates were compared to major DBS studies and reports focusing on the risk of infection due to externalization of DBS leads. Results were visualized using descriptive statistics.

Between January 2008 and November 2019, DBS surgery was performed in 528 patients (389/139 patients in the LFP/non-LFP group), mainly for movement disorders such as Parkinson's disease (308), dystonia (93), and essential tremor (86). Of the patients, 72.9% participated in LFP recordings. The incidence of infections in the acute postsurgical phase (3 months) was 2.46% and did not differ significantly between the LFP group (1.8%) and the non-LFP group (4.32%). The overall incidence after 1 year amounted to 3.6% (19 patients) with no difference between LFP/non-LFP groups. Incidence rates reported in the literature show a large variety (2.6-10%), and the incidence reported here is within the lower range of reported incidences.

This study demonstrates that DBS is a surgical procedure with a low risk of infection in a large patient cohort. Importantly, it shows that LFP recordings do not have a significant effect on the incidence of infections in patients with externalization. With a representative cohort of more than 380 patients participating in LFP-recordings, this underlines LFP as a safe method in research and supports further use of this method, for example, for the development of adaptive stimulation protocols [1].

Clinical records of 187 patients with directional DBS electrodes were screened for CT scans in addition to the routine postoperative CT. The orientation angle of each electrode at a specific point in time was reconstructed from CT artifacts using the DiODe algorithm implemented in Lead-DBS. The orientation angles over time were compared with the originally measured orientations from the routine postoperative CT.

Multiple CT scans were identified in 18 patients and the constancy of the orientation angle was determined for 29 leads at 48 points in time. The median time difference between the observations and the routine postoperative CT scan was 82 (range 1-811) days. The mean difference of the orientation angles compared to the initial measurement was -1.1 ± 3.9° (range -7.6 to 8.7°). Linear regression showed no relevant drift of the absolute value of the orientation angle over time (0.8°/year, adjusted R2: 0.040, p = 0.093).

The orientation of directional leads was stable and showed no clinically relevant changes either in the first weeks after implantation or over longer periods of time [2].

Wolf et al. from Mannheim prospectively collected data from 11 consecutive patients (10 men, mean age at DBS implantation 52.6 ± 14.0 years) with chronic DBS for dystonia (n = 7), Parkinson's disease (n = 3), and essential tremor (n = 1) who underwent Implantable Pulse Generator IPG replacement switching from a CV NRC system (Activa® PC; Medtronic®) to a CC RC system (Vercise® RC; Boston Scientific®). Systematic assessments before and after IPG replacement were performed.

DBS technology switching at the time of IPG replacement due to battery depletion was at a mean of 108.5 ± 46.2 months of chronic DBS. No perioperative complications occurred. Clinical outcome was stable with overall mild improvements or deteriorations, which could be dealt with in short-term follow-up. Patients were satisfied with the new RC IPG.

This study confirms both the safety and feasibility of switching between different DBS technologies (CV to CC, NRC to RC, different manufacturers) in patients with chronic DBS. Furthermore, it shows how the management can be planned using available information from the previous DBS settings. Individual assessment is needed and might partly be related to the DBS target and the underlying disease. MR safety might be a problem with such hybrid systems [3].

Sobstyl et al., presented the operative experience of patients with movement disorders who developed intracerebral hemorrhage (ICH), which was identified on intraprocedural stereotactic computed tomography (CT) imaging performed immediately after deep brain stimulation (DBS) lead placement and prior to the implantation of further components of the DBS hardware.

Patients who underwent DBS lead implantation from January 2009 through December 2017 were included in the present study. Most of the surgeries were performed in a staged fashion. All patients were operated using identical surgical and intraprocedural imaging techniques, and no microelectrode recordings were done. Leksell Stereotactic G frame and neuronavigation software was utilized for all surgeries. Intraprocedural stereotactic CT was performed to confirm the precise position of the implanted DBS lead and to rule out any hemorrhagic complications.

Overall, 222 patients underwent 322 DBS lead implantations during 316 stereotactic procedures. Six patients exhibited early ICH recognized on intraprocedural stereotactic CT performed immediately after DBS lead placement; in addition, two patients developed delayed ICH due to large venous infarction. Four patients with ICH were asymptomatic. The ICH rate was 2.5% per electrode and 3.6% per patient; the permanent deficit rate was 1.2% per electrode and 1.8% per patient. The death rate due to ICH in our cohort was 0.6% per electrode and 0.9% per patient.

Intraprocedural stereotactic CT can not only visualize the implanted DBS lead in the stereotactic space but also rule out early ICH. Identified predisposing factors for development of ICH include patient's age, hypertension, and previous antiplatelet therapy. Careful planning of stereotactic trajectories plays a paramount role in reducing the rate of ICH in DBS surgery [4].

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18 patients underwent DBS with bilateral implantation of directional electrodes applying a 32-slice portable CT scanner in combination with microelectrode recording.

iCT led to a significant decrease in overall procedural time, despite performing multiple scans. In three of the initial 5 cases iCT caused an adjustment of the final electrodes demonstrating the learning curve and the necessity to integrate road mapping for the exchange of microelectrode to final electrode. Implementation of low-dose CT protocols added microelectrode iCT to the refined workflow, resulting in an intraoperative adjustment of a trajectory in one patient. Low-dose protocols lowered the total effective dose to 1.15 mSv, i.e. a reduction by a factor of 3.5 compared to a standard non-iCT DBS procedure, despite repeated iCTs. Intraoperative lead detection based on final iCT revealed a radial error of 1.04 ± 0.58 mm and a vector error of 2.28 ± 0.97 mm compared to the preoperative planning, adjusted by the findings of microelectrode recording.

iCT can be easily integrated into the surgical workflow resulting in an overall efficient time saving procedure. Repeated intraoperative scanning ensures reliable electrode placement, while low-dose scanning protocols prevent extensive radiation exposure. iCT of microelectrodes is feasible and led to an adjustment of one electrode [5)].

Sedatives and opioids used during deep brain stimulation (DBS) surgery interfere with optimal target localization and add to side effects and risks, and thus should be minimized.

To retrospectively test the actual need for sedatives and opioids when cranial nerve blocks and specific therapeutic communication are applied.

In a case series, 64 consecutive patients Zech et al. from University Hospital Regensburg, treated with a strong rapport, constant contact, non-verbal communication and hypnotic suggestions, such as dissociation to a “safe place,” reframing of disturbing noises and self-confirmation, and compared to 22 preceding patients under standard general anesthesia or conscious sedation.

With introduction of the protocol the need for sedation dropped from 100% in the control group to 5%, and from a mean dose of 444 mg to 40 mg in 3 patients. Remifentanil originally used in 100% of the patients in an average dose of 813 µg was reduced in the study group to 104 µg in 31% of patients. There were no haemodynamic reactions indicative of stress during incision, trepanation, electrode insertion and closure.

With adequate therapeutic communication, patients do not require sedation and no or only low-dose opioid treatment during DBS surgery, leaving patients fully awake and competent during surgery and testing [6)].

In a retrospective review of 323 cases with 546 leads placed (August 2011-October 2014) in the Barrow Neurological Institute, University of Arkansas for Medical Sciences. In 52% (n = 168) of cases, patients were asleep under general anesthesia without MER. Multivariate regression identified independent predictors of reduced surgery time and improved stereotactic accuracy.

MER was an independent contributor to increased procedure time (+44 min; P = .03). Stereotactic accuracy was better in asleep patients. Accuracy was improved with frame-based stereotaxy at head of bed 0° vs frameless stereotaxy at head of bed 30°. Improved accuracy was also associated with shorter procedures (r = 0.17; P = .049). Vector errors were evenly distributed around the planned target for the globus pallidus internus, but directionally skewed for the subthalamic (medial-posterior) and ventral intermediate nuclei (medial-anterior).

Distinct procedural variables in DBS surgery are associated with reduced case times and improved stereotactic accuracy [7)].

Postoperative lead localisations of 10 patients (19 hemispheres) were analysed in each individual patient based on Brainlab software (native space) and after normalization into the MNI space and application of 4 different human brain atlases using Lead-DBS toolbox within Matlab (template space). Each patient's STN was manually segmented and the relation between the reconstructed lead and the STN was compared to the 4 atlas-based STN models by applying the Dice coefficient. The length of intraoperative electrophysiological STN activity along different microelectrode recording tracks was measured and compared to reconstructions in native and template space. Descriptive non-parametric statistical tests were used to calculate differences between the 4 different atlases. RESULTS:

The mean STN volume of the study cohort was 153.3 ± 40.3 mm3 (n = 19). This is similar to the STN volume of the DISTAL atlas (166 mm3; p = .22), but significantly larger compared to the other atlases tested in this study. The anatomical overlap of the lead-STN-reconstruction was highest for the DISTAL atlas (0.56 ± 0.18) and lowest for the PD25 atlas (0.34 ± 0.17). A total number of 47 MER trajectories through the STN were analysed. There was a statistically significant discrepancy of the electrophysiogical STN activity compared to the reconstructed STN of all four atlases (p < .0001). CONCLUSION:

Lead reconstruction after normalization into the MNI template space and application of four different atlases led to different results in terms of the DBS lead position relative to the STN. Based on electrophysiological and imaging data, the DISTAL atlas led to the most accurate display of the reconstructed DBS lead relative to the DISTAL-based STN [8].

2017

Ramayya et al. reviewed medical records of patients over the age of 18 who underwent DBS surgery at Pennsylvania Hospital of the University of Pennsylvania between 2009 and 2014. They identified patients who were readmitted to an inpatient medical facility within 30 days from their initial discharge.

Over the study period, 23 (6.6%) of 347 DBS procedures resulted in a readmission to the hospital within 30 days. Causes of readmission were broadly categorized into surgery-related (3.7%): intracranial lead infection (0.6%), battery-site infection (0.6%), intracranial hematoma along the electrode tract (0.6%), battery-site hematoma (0.9%), and seizures (1.2%); and nonsurgery-related (2.9%): altered mental status (1.8%), nonsurgical-site infections (0.6%), malnutrition and poor wound healing (0.3%), and a pulse generator malfunction requiring reprogramming (0.3%). Readmissions could be predicted by the presence of medical comorbidities (P < .001), but not by age, gender, or length of stay (P s > .15).

All-cause 30-day readmission for DBS is 6.6%. This compares favorably to previously studied neurosurgical procedures. Readmissions frequently resulted from surgery-related complications, particularly infection, seizures, and hematomas, and were significantly associated with the presence of medical comorbidities (P < .001). [9].

2016

Two hundred and six DBS electrodes were implanted in the subthalamic nucleus (STN) in 110 patients with Parkinson's disease. All patients underwent iMRI after implantation to define the accuracy of lead placement. Fifty-six DBS electrode positions in 35 patients deviated from the center of the STN, according to the result of the initial postplacement iMRI scans. Thus, we adjusted the electrode positions for placement in the center of the STN and verified this by means of second or third iMRI scans. Recording was performed in adjusted parameters in the x-, y-, and z-axes. RESULTS Fifty-six (27%) of 206 DBS electrodes were adjusted as guided by iMRI. Electrode position was adjusted on the basis of iMRI 62 times. The sum of target coordinate adjustment was -0.5 mm in the x-axis, -4 mm in the y-axis, and 15.5 mm in the z-axis; the total of distance adjustment was 74.5 mm in the x-axis, 88 mm in the y-axis, and 42.5 mm in the z-axis. After adjustment with the help of iMRI, all electrodes were located in the center of the STN. Intraoperative MRI revealed 2 intraparenchymal hemorrhages in 2 patients, brain shift in all patients, and leads penetrating the lateral ventricle in 3 patients. CONCLUSIONS The iMRI technique can guide surgeons as they adjust deviated electrodes to improve the accuracy of implanting the electrodes into the correct anatomical position. The iMRI technique can also immediately demonstrate acute changes such as hemorrhage and brain shift during DBS surgery [10].

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