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Anesthesiologic regimen and intraoperative delirium in deep brain stimulation surgery for Parkinson's disease☆

M. Lange [a,b], N. Zech [b,c], M. Seemann [b,c], A. Janzen [b,d], D. Halbing [a], F. Zeman [e], C. Doenitz [a], E. Rothenfusser [b,d], E. Hansen [b,c], A. Brawanski [a], J. Schlaier [a,b,*]

[a] Department of Neurosurgery, University of Regensburg, Medical Center, Germany
[b] Centre for Deep Brain Stimulation, University of Regensburg, Medical Center, Germany
[c] Department of Anesthesiology, University of Regensburg, Medical Center, Germany
[d] Department of Neurology, University of Regensburg, Medical Center, Germany
[e] Center for Clinical Studies, University of Regensburg, Medical Center, Germany

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ABSTRACT

Background: In many centers the standard anesthesiological care for deep brain stimulation (DBS) surgery in Parkinson's disease patients is an asleep–awake–asleep procedure. However, sedative drugs and anesthetics can compromise ventilation and hemodynamic stability during the operation and some patients develop a delirious mental state after the initial asleep phase. Further, these drugs interfere with the patient's alertness and cooperativeness, the quality of microelectrode recordings, and the recognition of undesired stimulation effects. In this study, we correlated the incidence of intraoperative delirium with the amount of anesthetics used intraoperatively.
Methods: The anesthesiologic approach is based on continuous presence and care, avoidance of negative suggestions, use of positive suggestions, and utilization of the patient's own resources. Clinical data from the operations were analyzed retrospectively, the occurrence of intraoperative delirium was extracted from patients' charts. The last 16 patients undergoing the standard conscious sedation procedure (group I) were compared to the first 22 (group II) psychologically-guided patients.
Results: The median amount of propofol decreased from 146 mg (group I) to 0 mg (group II), remifentanyl from 0.70 mg to 0.00 mg, respectively ($P < 0.001$ for propofol and remifentanyl). Using the new procedure, 12 of 22 patients (55%) in group II required no anesthetics. Intraoperative delirium was significantly less frequent in group II ($P = 0.03$).
Conclusions: The occurrence of intraoperative delirium correlates with the amount of intraoperative sedative and anesthetic drugs. Sedation and powerful analgesia are not prerequisites for patients' comfort during awake-DBS-surgery.

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1. Introduction

Deep brain stimulation (DBS) of the subthalamic nucleus (STN) has been shown in level I trials to be superior to medical treatment in patients with advanced Parkinson's disease (PD) regarding quality of life and motor outcomes [1–3]. Although under constant debate in most DBS centers, the patients need to be at least intermittently awake during surgery to clinically evaluate improvement of the cardinal PD symptoms and stimulation-induced side effects [4–9]. Intraoperative delirium (IOD) however — with agitation, disturbed cooperation, and disorientation — is not uncommon in awake PD-patients in the operating room (OR) during STN-DBS and can severely compromise clinical evaluation. Postoperative delirium (POD) as well as perioperative delirium has been described by several authors, with an incidence of 1% to 33% [10–19]. However, so far most reports do not distinguish clearly between the time of occurrence intra-, peri-, and post-operatively and the terms “delirium” and “confusion” in PD-STN-DBS.

In general, local anesthesia (LA) is recommended for DBS to facilitate clinical testing [4–9], some authors report that DBS surgery can be performed under general anesthesia (GA) [11,18,20,21]. Apart from a propofol/remifentanyl narcosis alternative anesthesiologic settings have been proposed so far for DBS under GA, like ketamine/remifentanil- and dexmedetomidine-based regimens [22,23]. But in principle GA can severely change microelectrode recordings (MER) from the STN and more stimulation-induced side effects have been described in patients with STN-DBS under GA [17,24]. MER-guided clinical testing of multiple trajectories has been reported to be safe

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* Corresponding author at: Department of Neurosurgery, University of Regensburg, Medical Center, Franz-Josef-Strauss-Allee 11, 93053 Regensburg, Germany.
E-mail address: juergen.schlaier@ukr.de (J. Schlaier).

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[25,26], has been recommended for target definition [27–29], and potentially improves clinical motor outcomes [25,30]. Other authors, however, discuss that using MER could increase the risk for intracerebral hemorrhages [31] and that not using MER does not worsen clinical outcome [32–34]. In many centers, anesthesia for PD-DBS is therefore performed similarly to awake craniotomies as an asleep–awake–asleep procedure under local anesthesia [35]. Often, conscious sedation or sometimes GA is used during fixation of the stereotactic ring and the preoperative stereotactic imaging [5,7,36,37]. In the OR, propofol and remifentanyl are administered frequently during burr hole trepanation [36,38,39]. It has to be stopped immediately after drilling, so as not to influence MER and clinical testing. After clinical testing of the first side, patients are usually sedated again and often remifentanyl is given one more time for the second burr hole. This asleep–awake–asleep procedure was described as the standard of anesthesiologic care for DBS surgery in PD-patients [40]. However, anesthetics, analgesics, and sedatives can interfere with ventilation and hemodynamic stability [36,41]. Cases of myocardial infarction [42] or panic attacks with abortion of the procedure [43] have been reported. In addition, these drugs can compromise the patient's alertness and cooperativeness, the quality of microelectrode recordings, and the recognition of undesired stimulation effects [17,36].

Adapted from the awake craniotomy protocol at the authors' institution, we used the same "awake–awake–awake-technique" (AAAT) for DBS procedures. It consists of regional anesthesia (scalp blocks), continuous care, and therapeutic communication, largely avoiding narcotics and opioids to provide calm and fully alert patients for optimal intraoperative testing [44,45]. During awake craniotomies with this technique, patients were more alert than after regional anesthesia with slight sedation [46].

The objective of this first analysis of AAAT in DBS surgery was to determine whether our approach leads to less psychiatric intraoperative side effects such as agitation and disorientation than conscious sedation in STN-DBS for PD, and how the two regimens compare in terms of patients' comfort.

2. Methods

In this retrospective, clinical study, we included 38 patients (13 females, 25 males) with advanced PD, who consecutively underwent bilateral STN-stimulation. Patient age ranged from 52 to 76 years (average: 64.1 years). The duration of the disease from the first diagnosis to the operation ranged from 7 to 25 years (average: 12.9 years).

2.1. Patient selection

Only patients with PD with disabling motor fluctuations, severe tremor, or severe medication side effects despite optimal medical treatment received surgery. All patients responded well to L-Dopa in the standardized preoperative L-Dopa challenge during practically defined OFF-condition.

Exclusion criteria were age >75 years (one 76-year old female patient was included because of her excellent biologic condition), dementia, frontal lobe cognitive impairment, insufficient compliance, coagulopathies, immunosuppression, and tremor from other causes than PD. Patients were also excluded if magnetic resonance imaging (MRI) showed pronounced cerebral atrophy and signs of severe cerebral subcortical vascular encephalopathy.

Prior to surgery, dopamine agonists were withdrawn several days in advance and L-Dopa monotherapy was established. In some patients, two days before surgery this was replaced by a continuous subcutaneous apomorphine infusion that was not interrupted until 1 h before MER in the OR. In most of the patients, L-Dopa was terminated late afternoon on the day before surgery.

2.2. Stereotactic imaging

All MRI scans (1.5 Tesla; Avanto, Siemens, Erlangen, Germany) for target and trajectory planning were performed under general anesthesia two days prior to electrode implantation. A stereotactic computerized tomography (CT)-scan (Sensation16, Siemens, Erlangen, Germany; CRW, Radionics, Burlington, MA) was done in the morning of the day of surgery. All data sets were fused on a computer workstation to the volumetric T1-weighted MRI (iPlan Stereotaxy 3.0, BrainLab, Feldkirchen, Germany).

The axial slice (z-coordinate), which showed the largest diameter of the red nucleus, was chosen for targeting on T2-weighted images [47]. The trajectories of the electrodes were planned on volumetric T1-weighted MPRage contrast-enhanced images and controlled on CT slices after fusion, according to the configuration of the "ben-gun" manual microdrive (Medtronic, Minneapolis, MN).

2.3. Anesthesiological management, psychological guidance

Patients were divided into 2 groups. In group I, the patients' scalp was infiltrated with LA just at the sites where the pins of the stereotactic frame were mounted. MER and clinical testing were performed during the awake phase in a conscious sedation ("asleep–awake–asleep") setting.

In group II the anesthesiologic team systematically used scalp blocks [48] and activated patients' own resources by psychological guidance. Propofol and remifentanyl were only given if medically required or actively demanded by the patient.

No patient received benzodiazepines or beta-blockers.

The last 16 patients undergoing the standard awake–asleep–awake procedure (group I) were compared to the first 22 (group II) patients treated with the new procedure, using no or only very little anesthetics. Retrospectively the duration of surgery, the amount of analgesics (remifentanyl) and narcotics (propofol), and the frequency of adverse events (AEs) were analyzed and compared between the two groups.

All patients were visited by the anesthetist one day prior to surgery. On the day of surgery "rapport" is established and continuous presence and care is assured by the anesthetist already before fixation of the stereotactic ring for the planning-CT. Nonverbal support is maintained by hand-in-hand and hand-on-shoulder contact providing both assurance of care and monitoring of tension and ventilation. Negative suggestions are carefully avoided, and a communication-based patient-attendance and -guidance are used to give positive suggestions and utilize the patient's own resources. The patient is offered dissociation to a "safe place" (e.g. garden, hiking tour, beach), "reframing" of disturbing sensations and noises like the burr hole drill sound (e.g. power mower, motorbike, helicopter), relaxing music and breathing, metaphors and "pacing and leading".

2.4. Microelectrode recordings

All patients were operated awake to enable robust MER. Up to five parallel microelectrodes (FHC, Bowdoin, ME, USA) were advanced simultaneously with a manual microdrive. Two neurologists (ML and AJ) and one neurosurgeon (JS) assessed the MER and the range of positive STN signals for each trajectory.

2.5. Intraoperative clinical testing

Clinical testing was performed with the macro tip of the microelectrodes (FHC, Bowdoin, ME), starting with the trajectory that matched best to the anterior–superior–lateral ("sensorimotor") part of the STN [49,50]. Depending on the clinical thresholds and the occurrence of side effects, we tested along 0–3 additional trajectories with STN-positive MER-signals, each at 2–3 different depths. Intraoperative clinical testing graded finger tapping and fast, alternating pronation/

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