A Simple Method to Improve the Safety and Comfort of Anesthesia for Deep Brain Stimulation: Case Report and Literature Review

Yi-Hui Lee, M.D.[1], Kuen-Bao Chen M.D.[2], Yu-Cheng Kuo, M.D.[3,4,5], Chi-Tsung Chien, M.D.[1,6], Chia-Wen Chen, M.D.[2,7]

[1] Department of Anesthesiology, Sijhih Cathay General Hospital, Taipei, Taiwan
[2] Department of Anesthesiology, China Medical University Hospital, Taichung, Taiwan
[3] Department of Radiation Oncology, China Medical University Hospital, Taichung, Taiwan
[4] Department of Biomedical Imaging and Radiological Science, China Medical University, Taichung, Taiwan
[5] Department of Biomedical Imaging and Radiological Sciences, National Yang-Ming University, Taipei, Taiwan
[6] Institute of Brain Science, National Yang-Ming University, Taipei, Taiwan
[7] Graduate Institute of Clinical Medical Science, China Medical University, Taichung, Taiwan

Corresponding Author:
Chia-Wen Chen, MD
Department of Anesthesiology
China Medical University Hospital
2 Yuh-Der Road, North District,
Taichung 404, Taiwan
Tel: 886-4-22052121#3562
Fax: 886-4-22360795
E-mail: kib88977@gmail.com

Running head:
Safety Anesthesia for Deep Brain Stimulation

A Simple Method to Improve the Safety and Comfort of Anesthesia for Deep Brain Stimulation: Case Report and Literature Review

Abstract

Deep brain stimulation (DBS) is widely accepted in the treatment of Parkinson's disease and other movement disorder. Local anesthesia or monitored anesthesia with or without light sedation is the most common method for patients undergoing deep brain stimulation. Many complications occurred during this procedure while respiratory complications are the most be feared as the fixed frame may make the access to the patient's airway difficult. Hereby we report a simple method using local anesthetics to enhance tolerance of endotracheal tube with and without sedation. We believe this modification improves the safety and comfort of anesthesia for deep brain stimulation.

Key words:

deep brain stimulation (DBS), Parkinson's disease, anesthesia, local anesthetic, epidural catheter

Implantation of deep brain stimulators is now widely accepted for the treatment of Parkinson's disease.[1,2,3,4] The most common anesthetic technique used for DBS procedures was local anesthesia or monitored anesthesia using light sedation because intraoperative evaluation of clinical signs ensures optimal placement of the electrodes.[5] However, airway, respiratory, neurologic, and psychologic/psychiatric complications have been reported.[5] In particular, the fixed stereotactic head frame may cause difficulty in accessing the patient's airway. DBS is a procedure which presents many anesthetic challenges.[5] Surgeons and anesthesiologists might meet the dilemma between patients' comfort and optimal surgical conditions including safety and intraoperative neuromonitoring. Here, we presented a simple method to improve the safety and comfort of anesthesia for DBS.

CASE REPORT

A 67-year-old man with Parkinson's disease was scheduled for DBS. His past medical history included type II diabetes mellitus and hypertension with regular drug control. Preoperative evaluation including chest X-ray, electrocardiography, and laboratory studies revealed grossly normal except mild cardiomegaly and mild anemia (hematocrit was 30%). In the operative room, standard monitors including electrocardiography, noninvasive cuff blood pressure, and pulse oximeter were set and the vital signs revealed normal with blood pressure 136/85 mmHg, heart rate 78 beats per minute, and O_2 saturation 95% in room air. An arterial line and a large bore venous catheter were placed for closely blood pressure monitoring and preventing accident bleeding during the operative period. We modified the 7.5mm ID nasal endotracheal tube (ETT) with an epidural catheter (B|BRAUN, Perfix®catheter, 20G) which tip was fixed above the distal end of the cuff at a distance of 1mm away (Fig. 1). The patient was premedicated with intravenous injection of midazolam 1 mg and alfentanil 500 μ g. After adequate preoxygenation, the patient was intubated using this modified nasal ETT awakely under fiberscopic guidance. 2ml of 2% lidocaine was infiltrated around the modified ETT cuff intermittently via the epidural catheter during the procedure to reduce the stimulation of the ETT cuff. We used total intravenous anesthesia with infusion of alfentanil (0.3-0.5 μ g/kg/min) and

dexmedetomidine (0.3-0.5 μ g/kg/hr) intermittently during the periods without neural intervention and testing. Additional intravenous bolus of propofol 10-20 mg was performed only when the patient was more anxiety and restlessness. Total intravenous anesthesia was stopped before stimulation testing to allow the patient to be awake and cooperative. The patient's ventilation was maintained with spontaneous breathing in FiO_2 50% and the tidal volume was kept about 350-500 ml. The whole course was smoothly completed in this four-hour operation and the patient kept spontaneous breathing without any bucking or coughing, and remained hemodynamically stable. No hypoxemia or hypercarbia was noted intraoperatively. At emergence from the DBS procedure, the patient was waked and smoothly extubated. No further complications were noted in postoperative follow-up.

DISCUSSION

DBS at high frequency was first used in 1977 to replace thalamotomy in treating the characteristic tremor of Parkinson's disease, and has subsequently been applied to the pallidum and the subthalamic nucleus (STN).[6] It is increasingly accepted in the treatment of Parkinson's disease and other movement disorder, such as cerebellar outflow tremors, and dystonia.[7,8,9] The common anesthetic aims are to: (1) provide patient comfort and optimal surgical conditions such as hemodynamic stability and respiratory sufficiency, (2) facilitate intraoperative monitoring, including neuromonitoring for target localization, and (3) rapidly diagnose and treat any complications. Numerous anesthetic techniques have been described including and "awake" technique with local anesthesia or scalp nerve blockade, monitored anesthesia with intravenous sedation, and general anesthesia. Among these, local anesthesia or monitored anesthesia care with or without light sedation is most popular in DBS procedures.

However, surgeons or anesthesiologists meet the dilemma between patients' comfort and optimal surgical conditions since these patients frequently are in old age with complex medical problems[10, 11] as well as their more severe condition for movement disorders. Since the patients are unable to alter their position with head fixed via the head frame to the operation table once the procedure is underway, these

procedures with long duration might cause patients discomforts and anxiety under local anesthesia or nerve blockade and thus influence their hemodynamic stability. Further tremors, agitation, seizures, and even fatigue, might also happen. All of these increase the risk of perioperative neurologic complications, including intracranial hemorrhage as well as cardiovascular events. In addition, the DBS procedure using monitor anesthesia with light sedation might cause patients to be difficulty in breathing or even complete airway obstruction,[12] which interferes the proceeding and the safety of the operation.

General anesthesia has also been used for patients underwent DBS, especially for those unsuitable for a conscious technique, such as those with concurrent psychiatric problems, discomfort due to off-period dystonia, or severe anxiety with associated hypertension. However, almost all analytic or anesthetic drugs might have adverse effects on neurophysiologic monitoring[4] thus make the intraoperative assessment of motor disability and dyskinesia being impossible. Although some believes general anesthesia has no significant impact on clinical surgical results,[13] there are still debates of this opinion. A retrospective study on the effect of general anesthesia showed that the residual motor disability and intensity of stimulation appeared to be slightly higher in patients under general anesthesia, implying that STN stimulation was less precise the absence of intraoperative clinical assessment.[14]

In our case, we chose monitored anesthesia with light sedation only during the period of nonintervention, which provide more comfort and safety for our patient as well as minimize the disturbance of neuromonitoring. We used alfentanil and dexmedetomedine because of their short duration. They were only given during the periods of nonintervention to reduce their mental stress, and the infusions were stopped before stimulation testing to allow the patient to be awake and cooperative to participate the physiologic localization and neuromonitoring.[5] In addition, the use of dexmedetomedine for sedation during deep brain stimulator insertion was shown to result in better control of blood pressure and need less antihypertensive medications.[15]

Besides, respiratory complications must always be aware because of the fixed stereotactic head frame could make access to the patient's airway difficult or even impossible[12] during emergent condition. This should be taken more concern even in local anesthesia or if the sedatives or anesthetics have been used, which might suppress respiratory driving in turns inducing further hypoxemia or hypercarbia. Although the rate of perioperative risks is around 1.6%,[16] patients' weaker cardiopulmonary reserve may arise not only from old age and co-morbidities, but also from Parkinson's disease which, itself alone, might cause patients' pulmonary function impairment.[17] We used preoperatively nasal ETT intubation for preventing further pulmonary complications while our patient is awake. Intratracheal local

anesthetics infiltration through the epidural catheter reduced the discomfort and stimulation of ETT cuff, while also inhibited cough reflex through the complete course. It decreases the risks of respiratory suppression by sedatives, which might cause hypoxemia or hypercapnia, both in turn result in increasing intracranial pressure and neurological complications.[18]

This application is similar to the technique used by Huncke et al.[19] for awake-asleep-awake techniques in awake craniotomy. Patients could well tolerate the ETT being awake and cooperative during the periods of nonintervention and neuromonitoring with suspending intravenous medications. The patient could be spontaneously breathing, and gentle assisted manual ventilation was only given to maintain adequate tidal volume. End-tidal carbon dioxide could be monitored for detecting venous air embolism. Modifications using extraglottic airway devices such as laryngeal masks are also widely used,[20] but ETT intubation still provides more securing ventilation without needs for emergent airway management as mal-position of these devices. In addition, the late stages of Parkinson's disease present high incidence of aspiration pneumonia.[17] In these cases, ETT provides better manual assisted ventilation than extraglottic airway devices for decreasing the risks of gastric aspiration[21] and hypercapnia.

CONCLUSION

At present, there are still no studies comparing different anesthetic techniques and perioperative risks for DBS procedures. The balance between patient's comfort and surgical consideration for anesthesiologists is challenging and, thus, might be also considered case by case. In our opinion, a good ventilation support as we use provides benefits for reducing not only respiratory but also possible neurological complications, especially in patients with more severe condition. Further risk-to-benefit assessment needs more prospective studies.

REFERENCES

1 Deep-brain stimulation of the subthalamic nucleus or the pars interna of the globus pallidus in Parkinson's disease. *N Engl J Med*. 2001; 345: 956-963.

2 Krack P, Batir A, Van Blercom N, et al. Five-year follow-up of bilateral stimulation of the subthalamic nucleus in advanced Parkinson's disease. *N Engl J Med*. 2003; 349: 1925-1934.

3 Vingerhoets FJ, Villemure JG, Temperli P, et al. Subthalamic DBS replaces levodopa in Parkinson's disease: two-year follow-up. *Neurology*. 2002; 58: 396-401.

4 Goetz CG, Poewe W, Rascol O, Sampaio C. Evidence-based medical review update: pharmacological and surgical treatments of Parkinson's disease: 2001 to 2004. *Mov Disord*. 2005; 20: 523-539.

5 Khatib R, Ebrahim Z, Rezai A, et al. Perioperative events during deep brain stimulation: the experience at Cleveland clinic. *J Neurosurg Anesthesiol*. 2008; 20: 36-40.

6 Benabid AL. Deep brain stimulation for Parkinson's disease. *Curr Opin Neurobiol.* 2003; 13: 696-706.

7 Tronnier VM, Fogel W, Krause M, et al. High frequency stimulation of the basal ganglia for the treatment of movement disorders: current status and clinical

results. *Minim Invasive Neurosurg.* 2002; 45: 91-96.

8 Krauss JK, Yianni J, Loher TJ, et al. Deep brain stimulation for dystonia. *J Clin Neurophysiol*. 2004; 21: 18-30.

9 Rodriguez-Oroz MC, Obeso JA, Lang AE, et al. Bilateral deep brain stimulation in Parkinson's disease: a multicentre study with 4 years follow-up. *Brain.* 2005; 128: 2240-2249.

10 Nicholson G, Pereira AC, Hall GM. Parkinson's disease and anaesthesia. *Br J Anaesth.* 2002; 89: 904-916.

11 Burton DA, Nicholson G, Hall GM. Anaesthesia in elderly patients with neurodegenerative disorders: special considerations. *Drugs Aging.* 2004; 21: 229-242.

12 Venkatraghavan L, Manninen P, Mak P, et al. Anesthesia for functional neurosurgery: review of complications. *J Neurosurg Anesthesiol.* 2006; 18: 64-67.

13 Patel NK, Plaha P, Gill SS. Magnetic resonance imaging-directed method for functional neurosurgery using implantable guide tubes. *Neurosurgery.* 2007; 61: 358-365.

14 Maltete D, Navarro S, Welter ML, et al. Subthalamic stimulation in Parkinson disease: with or without anesthesia? *Arch Neurol.* 2004; 61: 390-392.

15 Rozet I, Muangman S, Vavilala MS, et al. Clinical experience with dexmedetomidine for implantation of deep brain stimulators in Parkinson's disease. *Anesth Analg.* 2006; 103: 1224-1228.

16 Poon CC, Irwin MG. Anaesthesia for deep brain stimulation and in patients with implanted neurostimulator devices. *Br J Anaesth.* 2009; 103: 152-165.

17 Mikaeele H, Arami M, Marandi M, et al. Respiratory Problems in Parkinson Disease. *Clinical Pulmonary Medicine.* 2009; 16: 139.

18 Bilotta F, Rosa G. 'Anesthesia' for awake neurosurgery. *Curr Opin Anaesthesiol.* 2009; 22: 560-565.

19 Huncke K, Van de Wiele B, Fried I, et al. The asleep-awake-asleep anesthetic technique for intraoperative language mapping. *Neurosurgery.* 1998; 42: 1312-1316.

20 Deiner S, Hagen J. Parkinson's disease and deep brain stimulator placement. *Anesthesiol Clin.* 2009; 27: 391-415.

21 Asai T. Editorial II: Who is at increased risk of pulmonary aspiration? *Br J Anaesth.* 2004; 93: 497-500.

Figure Legend

FIGURE 1. The modified nasal ETT to facilitate tolerance of intubation during DBS procedure. The modified ETT is a regular tracheal tube with an epidural catheter (B|BRAUN, Perfix®catheter, 20G) fixed along the wall of the lesser curvature of the ETT by a 3M™Trgaderm™ under aseptic technique. The tip of epidural catheter was fixed above the distal end of the cuff at a distance of 1 mm away (black arrow). Local anesthetics was infiltrated around the ETT cuff via the epidural catheter.

Figure 1.