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Review

Preanesthetic evaluation of a patient with a deep brain stimulator: a practical guide and checklist for patient safety☆

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Abstract As the patient population with deep brain stimulators grows, medical personnel need to be comfortable managing these patients because they will likely encounter them in practice. Caring for a patient with a deep brain stimulator during surgery or a procedure requires technical knowledge of the device and its possible interactions in order to take the correct precautionary measures. Here we discuss the key issues and questions that should be covered in every preanesthetic evaluation visit of a patient with a deep brain stimulator along with an evaluation checklist.

Deep brain stimulators (DBSs) are implantable electronic devices that electrically stimulate the brain. Initially used as a surgical treatment for Parkinson's disease, the indications for implantation have expanded to include not just movement disorders but also chronic pain disorders, seizure disorders, and psychiatric disorders [1–5]. As the number of patients with a DBS increases, so does the likelihood of medical personnel encountering a patient with an existing DBS undergoing surgery or a procedure separate from the DBS implantation. This requires that medical personnel have knowledge of the potential technical DBS device interactions and the required necessary precautions. This has been previously described in detail by Poon and Irwin [4] and will not be the focus here. Proper care of a patient with a DBS undergoing surgery or a procedure begins with a preanesthetic evaluation not just to ensure patient comfort and safety but also to prevent any unnecessary cancellations. Here we discuss the key issues and questions that should be covered in every preanesthetic evaluation visit of a patient with a DBS.

Typically, every patient with a DBS has a primary DBS manager, often their neurologist or neurosurgeon that implanted the device, that they see for routine follow-up in regard to their DBS. Before the preanesthetic evaluation, the patient should be seen by their primary DBS manager or manufacturer's representative for interrogation of their device to ensure sufficient battery life and integrity of the device and its settings. The make, model, and device number of the DBS should be ascertained [5,6]; often, the patient will have a card specifying this information. This will allow for effective communication over the phone with a

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manufacturer's representative if needed in an emergency. In addition, the primary manager of the DBS should be made aware of the upcoming surgery; he or she can supply information about the patient's DBS if the patient is unable, may be able to answer perioperative care concerns, assist in coordination of perioperative DBS device interrogations, and coordinate changes in medication dosing if needed if the DBS is to be temporarily deactivated [5]. Communication among health care team members ensures continuity of care.

If the upcoming surgery or procedure will involve any of the following: electrocautery, high likelihood of defibrillation or cardioversion, cardiac pacemaker device (external or internal), electroconvulsive therapy, or phacoemulsification, then there is a high likelihood that the DBS will need to be temporarily deactivated to maximize patient safety [1,4]. This is especially true the closer the surgical site is to the DBS and its components. Short-wave diathermy use is contraindicated [1,4–6]. If device deactivation is needed, the patient may have a personal controller to deactivate and reactivate the DBS; otherwise, the assistance of the manufacturer's representative may be required [1,6]. If the patient has a personal controller, he or she should be instructed to bring it on the day of his or her surgery or procedure. Regardless of whether a patient has a personal controller for the DBS, arrangements with a manufacturer's representative should to be made to test for DBS integrity and settings after the surgery if the DBS is deactivated temporarily or if any of the above-mentioned interventions are present during the surgery or procedure [1,4,5].

If appropriate arrangements with the manufacturer's representative cannot be made and the previously stated surgical interventions are to be used in close proximity to the DBS in an elective surgery, the case should be postponed. Ignoring proper precautions endangers the patient and the DBS, ranging from simple device deactivation to potential brain injury [4–6]. Although not ideal, if the manufacturer's representative cannot be made available, a discussion can be had between the patient, the surgeon, the primary DBS manager, and the anesthesiologist. The discussion should highlight the following issues: Is the surgical site far away from the DBS? How symptomatic is the patient if the device were to be deactivated? Does the patient know how to manage the DBS with a personal controller? Will follow-up DBS interrogation happen in a relatively timely manner? Will the surgery require general anesthesia or sedation (sedation would allow for communication with the patient)? The decision to proceed will come down to a safety discussion, but sedation for a toe surgery using bipolar cautery would likely have minimal risk for the patient and the DBS versus a general anesthetic for a carotid endarterectomy using monopolar cautery. As previously stated, specific technical DBS device interactions and the required necessary intraoperative precautions will not be discussed here, but highlights include use of bipolar cautery with minimal voltage and power over monopolar cautery and placement of defibrillation pads as far from the DBS as possible [1,4–6].

In addition, if the surgery or procedure will require magnetic resonance imaging (MRI), it is critical that the radiologist and radiology technician is aware of this so that manufacturer protocols can be followed. Specific settings of the MRI are needed and based on specific DBS models. MRI of a patient with a DBS, especially without proper precautions, can have devastating consequences of neuronal tissue injury [1,4,5].

As stated previously, DBSs are implanted for a variety of reasons. If a DBS needs to be temporarily disabled, the reason for implantation can impact the decision of when it is appropriate to deactivate. For example, in patients with Parkinson's disease, it may be preferable to deactivate the DBS after induction of anesthesia because of tremors interfering with line placement or neck muscle rigidity interfering with intubation [4–6]. This also applies to when it is appropriate to reactivate the DBS. Again with patients with Parkinson's disease, it is likely preferable to reactivate before wake up for patient comfort and airway security. If the physician plans on using the patient's personal controller for the DBS, he or she should ensure that he or she is comfortable using the controller, as the patient may be unable to reactivate the DBS because of either disease symptoms or logistical timing. Knowledge of the severity of symptoms when the DBS is deactivated is just as important as indication for implantation [5,6]. As previously mentioned, if the DBS is to be deactivated, depending on the indication for insertion, changes in perioperative medications may be indicated [5]. The primary DBS manager can typically assist in this. For example, a patient with Parkinson's disease may need a temporary increase in dose of his medications to deal with symptoms of deactivating the DBS.

A DBS consists of 3 components: the 2 leads, the extension, and the implanted pulse generator (IPG) [1–6]. Two 4-contact leads are tunneled from a burr hole in the skull and ordinarily inserted in the basal ganglia in each hemisphere, but the exact location depends on the indication for implantation [2–4]. Typically, the leads stimulate at a frequency of 130 to 180 Hz, with a 60- to 120-μs pulse width and a 1.0- to 3.6-V amplitude, but settings are disease and patient specific [2]. In addition, the specifications of which and how many of the contacts on the leads are anodes and cathodes of the DBS are patient specific [2,4]. The extension connects the intracranial leads to the IPG usually via subcutaneously tunneling around the neck. The IPG is most often subcutaneously placed in the chest or abdomen [1,2,4,5]. The location of these components can impact the surgery or procedure itself, or give rise to issues with central line placement. Accidental trauma to these components could be problematic, possibly necessitating additional surgery for correction, replacement of the device, or removal for infection [1,3,4,6]. A radiograph may be required to confirm location if there is question of the DBS's exact location [4].

Although there have been reports of intracranial bleeding at the time of DBS insertion, the risk of intracranial bleeding with perioperative anticoagulation with mature leads is