

Severe agitation following deep brain stimulation for parkinsonism

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ABSTRACT

The use of deep brain stimulation has become increasingly common for the treatment of movement disorders, including Parkinson disease. Although deep brain stimulation is generally very successful in alleviating the extrapyramidal symptoms of Parkinson disease, side effects can occur. This case report describes a patient presenting to the emergency department in a state of extreme aggression 3 days after a change in the parameters of his bilateral subthalamic nucleus stimulator. We review the complications of deep brain stimulation relevant to the emergency physician and provide some practical information on stimulator adjustment in an emergency.

RÉSUMÉ

Il est de plus en plus courant d'utiliser la stimulation cérébrale profonde pour traiter les troubles du mouvement, y compris la maladie de Parkinson. Bien que cette technique donne généralement de très bons résultats pour atténuer les symptômes extrapyramidaux de la maladie de Parkinson, des effets secondaires peuvent se produire. Nous présentons le cas d'un patient qui s'est présenté à l'urgence dans un état d'extrême agressivité trois jours après un changement aux paramètres des électrodes de stimulation bilatérale du noyau sous-thalamique. Nous passons en revue les complications de la stimulation cérébrale profonde pertinentes pour le médecin d'urgence et fournissons de l'information pratique sur le réglage du stimulateur en urgence.

Keywords: complications, deep brain stimulation, Parkinson disease, subthalamic nucleus

Deep brain stimulation (DBS) is becoming increasingly common for the treatment of extrapyramidal movement disorders, especially in patients with Parkinson

disease.^{1,2} The technique is also used for chronic pain syndromes and in research protocols involving depression,³ Tourette syndrome,⁴ and epilepsy.⁵ For the treatment of Parkinson disease, the procedure involves electrodes inserted into the brain and connected via subcutaneous wires to an implantable neural stimulator (INS), like a pacemaker, in the chest (Figure 1). The most common stimulation target in Parkinson disease is the subthalamic nucleus (STN). The INS can be switched on and off, and adjusted, via a remote control termed the access review therapy controller (ARTC). As of January 1, 2009, three main types of INS were in use: the single electrode Itrel 3 and Solettra and the magnetically shielded double-electrode Kinetra (all from Medtronic, Minneapolis, MN), used in bilateral STN-DBS. DBS has been shown to effectively suppress tremor and rigidity as well as akinesia and dyskinesia in Parkinson disease.¹

A variety of complications have been described and can present at any time after the initial electrode placement.⁶ DBS patients can present to the emergency department (ED) with infection, battery exhaustion, hardware failure, and the side effects of stimulation, which include stimulation-induced dyskinesias and behavioural problems.

CASE REPORT

A 76-year-old man with an 8-year history of progressive Parkinson disease despite maximum medical therapy was brought to the ED after sudden onset

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This article has been peer reviewed.



Figure 1. Deep brain stimulator electrodes in the subthalamus.

of increasingly aggressive behaviour over a 6-hour period. Three months previously, the patient had a DBS placed with regular neurosurgical follow-up, including a visit to the DBS clinic 3 days prior to his presentation to the ED. During this visit, neurostimulation had been increased to try to compensate for the progression of the patient's "freezing" episodes. The adjusted settings were an amplitude of 2.0 V bilaterally, a pulse width of 90 microseconds, and a frequency of 135 Hz on both right and left sides with monopolar stimulation using the most superficial contact on the left and second most superficial contact on the right.

The patient's other medical history included a diagnosis of bowel cancer 7 years previously with a recent recurrence and Hodgkin's lymphoma diagnosed 2 years previously and currently in remission. He had also suffered a non-ST segment elevation myocardial infarction 2 years previously and had known hyperlipidemia. His medications were levodopa-carbidopa IR 100/25 mg once daily; levodopa-carbidopa CR 100/25 mg, one tablet at 4 am and noon, half-tablet at 9 am and 10 pm, quarter-tablet at 4 pm; bromocriptine 5 mg four times daily; metoprolol 25 mg twice daily; doxazosin 4 mg at bedtime; simvastatin 20 mg daily; and aspirin 81 mg daily. There had been no recent

changes in his medication. The patient had no history of alcohol or recreational substance abuse and no previous psychiatric disorder.

The patient was sent to the ED from his nursing home after suddenly becoming aggressive toward other residents, entering their rooms and uttering profanities at them for no apparent reason. This behaviour was entirely out of keeping with the patient's normal demeanour. He was initially easily redirected but then began hiding in closets and startling nursing home residents and staff. Increasing movement and gait difficulties were also noted. When he became increasingly agitated, hurled himself to the floor, and chewed through the call bell cord, an ambulance was called. The police were also called to assist because he became physically violent, and the patient was transferred to hospital.

The patient presented to the ED at 2330h. He was alert but noncooperative with a detailed mental status examination. His temperature was 36.0°C (96.8°F) orally and blood pressure was 132/88 mm Hg with a heart rate of 72 beats per minute. His respiratory rate was 16 breaths per minute, and his oxygenation was 96% on room air. Blood sugar performed by paramedics was 4.4 mmol/L. The patient appeared agitated but was generally cooperative and denied any focal injury or pain. He had dyskinetic movements and was writhing in the stretcher. No localizing abnormalities were identified on cranial nerve and focused neurologic examination. The remainder of the physical examination was unremarkable. Complete blood count and serum electrolyte, creatinine, and liver tests were within the normal range.

The neurosurgical team following the patient for the DBS was contacted, and the suggestion was made to turn the electrode stimulator to the lowest setting (1.0 V bilaterally). By using the access controller, the INS unit was easily adjusted at the bedside by the emergency physician. The dyskinetic movements stopped immediately, and the patient slumped into bed, falling asleep shortly thereafter. He was easily arousable from sleep. Owing to the remarkable reversal after the DBS unit was turned to its lowest setting and the patient's subsequent normal neurologic examination, no further investigations were performed, and the patient was subsequently discharged back to the nursing home with follow-up in the neurostimulator clinic. The patient subsequently suffered further episodes of DBS-induced agitation that eventually resolved with further neurostimulator and medication adjustments.

Table 1. Postoperative complications of implantable neural stimulator insertion

Postsurgical complications
Hemorrhage (immediate)
Seizures (immediate)
Infection (0–6 mo)
Erosions (0–12 mo)
Stimulation side effects
Psychiatric
Depression/suicidality
Hypomania/euphoria
Anxiety
Hyperstimulation/aggression
Neurologic
Diplopia
Ataxia
Paresthesias
Rigidity/tremors
Hardware
Battery failure
Lead fracture/migration
Inadvertent on/off
Non-DBS-related emergencies
MRI exposure
ECG interpretation
Electrocautery/diathermy
Defibrillation

DBS = deep brain stimulation; ECG = electrocardiogram; MRI = magnetic resonance imaging.

DISCUSSION

DBS can improve the symptoms of advanced Parkinson disease considerably. However, like any surgical procedure with hardware placement, a number of complications can occur. The postoperative complications are listed in Table 1.

Postoperative complications

Most postsurgical complications occur during the immediate postoperative period while in hospital. A recent review describes a complication rate of 3 to 6% for intracranial hemorrhage and 4 to 10% for seizure.³ None of these events occurred out of hospital. Infection (chest 70%, scalp 30%, brain 0%) has been reported to occur in 2 to 15% of implantations up to 5 months postoperatively; however, the vast majority occur within 1 month of surgery.^{4,7,8} Skin flora, most often *Staphylococcus aureus*, are the most common organisms isolated. Prompt antibiotic coverage and neurosurgical referral are essential. Skin erosions

occurring anywhere along the path of the DBS device⁹ are often associated with infection and generally occur from 1 to 12 months postimplantation.⁶

Hardware failure

These types of malfunctions include battery failure, lead fracture and migration, and inadvertent switching off the INS unit. Most hardware failures are not emergencies and result in a patient's progressive return to pre-DBS symptoms. However, a portion of patients with advanced Parkinson disease may become so unwell that urgent referral and management by the neurosurgical team are required. Typical battery life of the INS is between 2 and 5 years. Lead migration can be assessed through imaging and occurs in up to 5% of patients, usually between 6 and 36 months after surgery.¹⁰ Lead fracture has been reported to occur in 5% of patients and generally occurs proximal to the INS, between 6 and 24 months after placement.¹¹ This is uncommon without a history of trauma.

A careful history is required to determine if the INS has been inadvertently shut off. Devices that cause strong electromagnetic fields, such as retail theft-detector gates, security gates at airports, high-voltage lines, and magnetic resonance imagers, as well as common household items that contain magnets (such as stereo speakers, cellular phones), have been known to inadvertently turn off the INS unit.¹² This is less common with the new magnetically shielded INS. Most patients possess an ARTC, which can be used to determine the on/off status of the INS (Appendix).

Stimulation side effects

This case report describes a stimulation-induced side effect of DBS. The resulting signs and symptoms of inappropriate stimulation may be recognized when they differ from the condition being treated by DBS. A variety of negative effects have been described, including depression,¹³ suicidality,¹⁴ apathy,¹⁵ mania,¹⁶ anxiety,¹⁷ hypersexuality,¹⁸ and aggressiveness.¹⁹ These symptoms generally occur soon after adjustment of the DBS and thus may occur months to years after implantation. If the symptoms are sufficient to require intervention, consultation with the neurostimulator team should be sought. The INS can be reduced to its lowest setting using the ARTC or shut off using either the ARTC or a magnet if the magnet control switch

has not been disabled. It may take hours for the adverse DBS-induced symptoms to resolve.

Non-DBS emergencies

Non-DBS emergencies are usually related to nonneurologic conditions where the presence of the INS may interfere with the presenting complaint. Electrocardiogram (ECG) interpretation may be impossible owing to artifact from a unipolar INS.²⁰ Temporarily turning the unit off or switching to a bipolar mode can eliminate the problem.²¹

Cardioversion for atrial fibrillation at 100 and 200 J in a patient with an older model thalamic INS (no longer in production), with the paddles placed over the right chest and apex of the heart, resulted in lesioning of the thalamus with peripheral paresthesias, allodynia, and dysesthetic pain syndrome.²² Another report describes a patient with an implantable cardioverter-defibrillator who suffered repeated defibrillations but remained neurologically asymptomatic.⁹ It is recommended that the INS voltage be turned off before cardioversion,⁹ but this should not delay emergency defibrillation. Additionally, the pads should be placed as far away as possible from the INS, ideally in the anterior/posterior position because most INSs are placed in the left chest wall.

Magnetic resonance imaging (MRI) has been safely performed in patients who have a DBS.⁹ However, the manufacturer recommends imaging under specific conditions owing to concerns about producing heating at the electrode-tissue interface in the brain.²³ The treating DBS team should be contacted prior to any MRI.

The manufacturer recommends avoidance of electrocautery in these patients. Monopolar electrocautery can cause electric shocks without any other neurologic sequelae.²⁴ It is recommended that the INS be turned off before electrocautery and the dispersive plate placed so that the electrical field does not cross the DBS system. Bipolar electrocautery has reportedly not caused any adverse effects in patients.^{12,24}

Diathermy (deep heat therapy) is absolutely contraindicated in DBS patients because heat may be conducted through the system. Two patients who were exposed to diathermy in the maxilla after tooth extraction²⁵ and for treatment of chronic scoliosis²⁶ developed a permanent vegetative state.

CONCLUSION

The use of deep brain and spinal cord stimulation devices is rising as they are used to treat Parkinson disease, chronic pain, and chronic depression. The emergency physician should be aware of the DBS, its side effects, and the measures needed to inactivate it.

Competing interests: None declared.

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