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ORIGINAL ARTICLE

Review of Complications of the DBS in Movement Disorder

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Objective: To review complications in deep brain stimulation (DBS) and to identify and manage DBS related problems.
Method: We present 11 cases-based review that can be encountered in DBS management among 161 DBS cases between February 2000 and July 2008.
Results: We experienced 2 erosion cases, 3 infection cases, 3 dislocation cases, one electrode fracture, one malposition and one delayed hemorrhage. The rate of complication was decreased year after year. Overall rate is 6.83%.
Conclusion: The most common complications were related to the electrode connectors.Complication due to the hardware are not life-threatening but are expensive in economic terms and in terms of patient suffering. As experience is gained, novel ways of avoiding complications and treating patients with complications will be developed.

KEY WORDS: Deep brain stimulation · Complication · Movement disorder.

INTRODUCTION

Deep brain stimulation (DBS) became an accepted form of surgical therapy for the treatment of medication-refractory neurological and neuropsychiatric disorders such as Parkinson's disease (PD), dystonia, essential tremor (ET), Tourette syndrome and obsessive compulsive disorder. The advantage is nondestructive, reversible, re-adjustable. But the disadvantage is high cost, need for regular follow up and programming, and complications associated with implantation of foreign bodies. Many medical centers implanted DBS each year, but there remains few review of complications. To review complication is necessary for post-operative care.

MATERIALS AND METHODS

We experienced 161 DBS cases between February 2000 and July 2008. Mean age of patients was 59.8 year old. We present a case-based review of 11 cases with complication to demonstrate common issues encountered in management (Table 1). Leads were implanted via magnetic resonance imaging (MRI) stereotaxy. The Leksell series G (Elekta, Atlanta, GA) frame was used. Perioperative cefazolin was administered before surgery and for 24 hours postoperatively. The frontal area, neck, and chest were shaved and prepped with ChloraPrep (2% chlorhexidine gluconate and 70% isopropyl alcohol) or povidone-iodine. The implantable pulse generator (IPG) and lead extenders were implanted in the same surgical setting as the lead in almost all cases. There were three skin incisions : a frontal incision for access to the burrhole site, a 1-cm parietal incision as the proximal tunneling point for the lead extender, and a 5-cm incision placed 1cm inferior to the clavicle for the IPG. No leads were temporarily externalized before permanent implantation. Neurosurgical residents or fellows were involved in approximately 60% of the procedures. We performed MRI, computed tomography and cervical spine X-ray to find any trouble-shooting problem.

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RESULT

We experienced 2 erosion cases, 3 infection cases, 3 dislocation cases, one electrode fracture, one malposition and one delayed hemorrhage. The rate of complication was decreased year after year (Fig. 1). Overall rate is 6.83%. These problems are categorized as 6 causes (Fig. 2).

Category 1 : Electrode fracture

A 48-year old man with 10 years history of ET underwent right globus pallidus internalis (Gpi) DBS placement and presented for waning benefit. The fracture of electrode was found. It was extended and repositioned (Fig. 3).

Table 1. Patient demography with complication

Age	Sex	DBS OP date	Revision date	Dx	OP name	Cause
62	M	2002-1-23	2003-4-21	PD	Revision-cable reposition	Dislocation of electrode d/t migration
79	F	2002-12-2	2003-9-3	PD	Revision-cable reposition	Dislocation of electrode d/t migration
48	M	2001-5-31	2005-3-16	ET	Revision-cable reposition	Electrode fracture
52	F	2005-6-20	2005-6-21	PD	Revision-cable reposition	Malposition of electrode
63	M	2004-8-12	2005-7-15	PD	Removal of Rt side system	Infection-deep
50	M	2004-5-17	2005-7-19	PD	Debridement & primary closure	Erosion
42	M	2005-5-16	2005-7-28	PD	Debridement & primary closure	Erosion
63	M	2005-9-12	2005-9-21	PD	Lt side generator pocket I&D	Infection generator pocket
44	F	2001-10-24	2005-10-24	PD	Revision-cable reposition	Dislocation of electrode d/t migration
44	M	2002-5-20	No operation	ET	IV antibiotics 6 weeks	Infection-deep
56	F	2007-11-21	2007-11-23	PD	Removal of hematoma	Hemorrhage : ICH, Rt. thalamus and Rt. IVH

DBS : deep brain stimulation, OP : operation, PD : parkinson's disease, ET : essential tremor, Dx : diagnosis, d/t : due to, I&D : incision and drainage, Rt : right, Lt : left

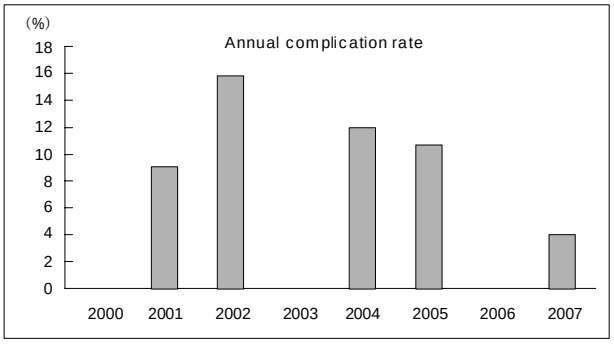


Fig. 1. Complication rate by calendar year showing decrease over time.

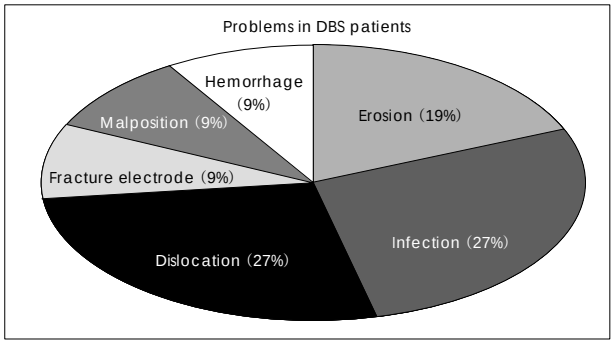


Fig. 2. Categorized 6 causes.

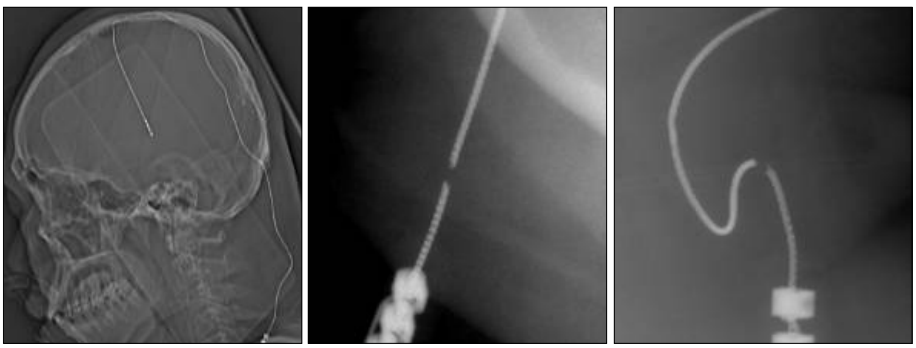


Fig. 3. A 48-year-old man with a 10-year history of ET underwent right GPi DBS placement. Interrogation of the device revealed electrode fracture on the X-ray. A second lead was re-implanted and repositioned.

Category 2 : Dislocation of electrode due to migration

A 79-year old woman with 6 years history of PD had bilateral Gpi DBS. 9 months later, dislocation of electrode was found. Reposition of electrode and extension was done (Fig. 4).

Category 3 : Malposition of electrode

A 52-year old woman underwent bilateral subthalamic nucleus (STN) DBS for advanced PD with 11 years course. In immediate follow up image, we found malposition of electrode.

We repositioned the electrodes (Fig. 5).

Category 4 : Infection

A 63-year old man presented with 26 history of PD underwent bilateral Gpi DBS 9 months later, he was admitted with high fever, pus discharge and redness at all over cables. In culture, Staphylococcus aureus was found. We removed right side system and did intravenous antibiotics therapy for 6 weeks (Fig. 6).

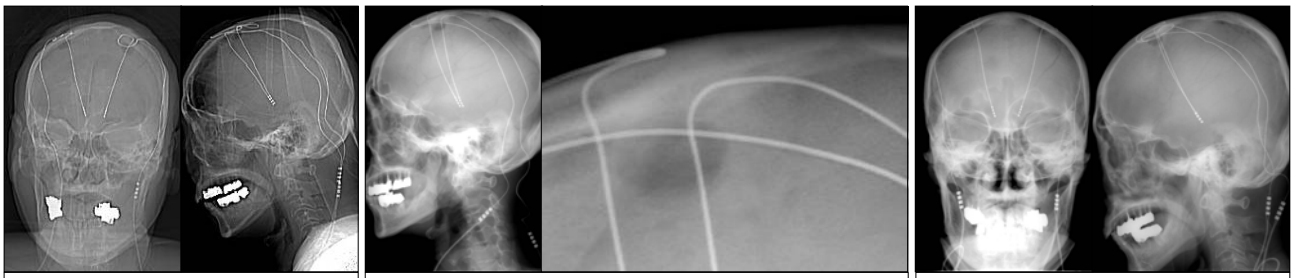


Fig. 4. A 79-year-old woman with 6 years history of PD underwent Gpi DBS. We checked X-ray immediately after operation. 9 months later, she complained resting tremor and bradykinesia. Dislocation of electrode was found. Reposition of electrode and extension was done.

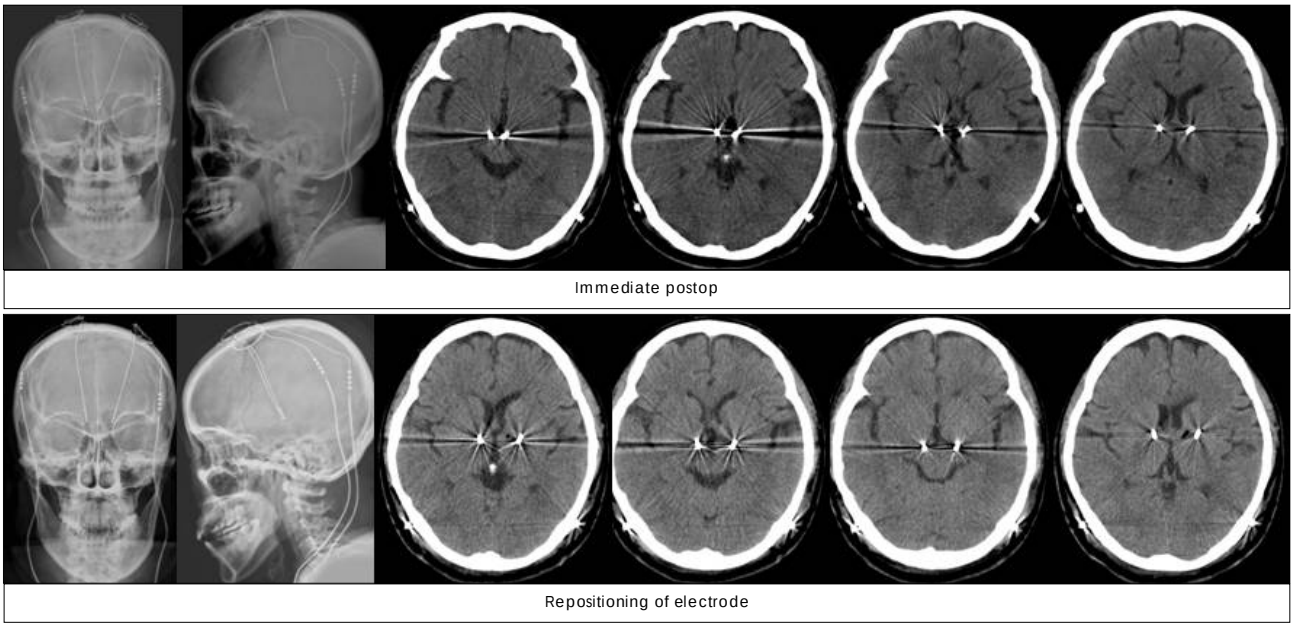


Fig. 5. A 52-year old woman underwent bilateral Subthalamic nucleus (STN) DBS for advanced PD with 11 years course. In immediate-follow-up image, we found too medial direction of electrode. We repositioned the electrodes.

Category 5 : Erosion

A 50-year old man with PD took bilateral Gpi DBS. 14 months later, erosion with exposure of connector was found. We did debridement and primary closure and intravenous antibiotics therapy during 4 weeks (Fig. 7).

Category 6 : Intraoperative hemorrhage

Acute intracranial hemorrhage and intraventricular hemorrhage in a 56-year old woman with PD was noted after placement of bilateral thalamic DBS. She underwent craniotomy and evacuation of hematoma immediately. The patient remains under good tremor control without neurologic deficit (Fig. 8).

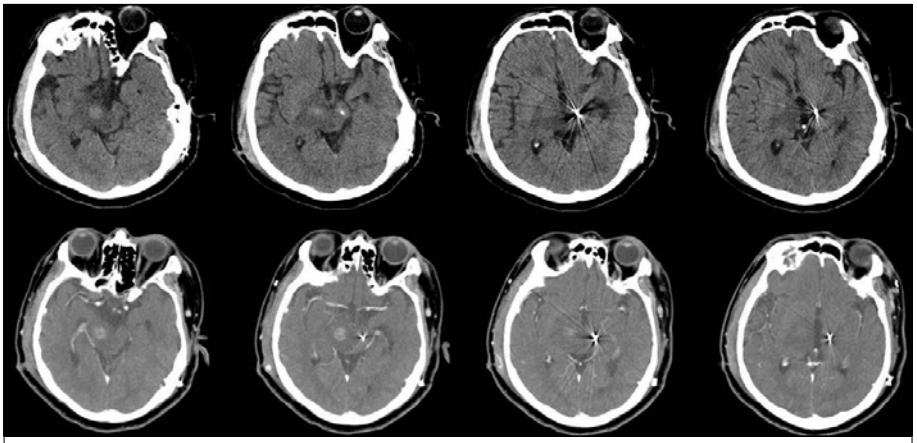
DISCUSSION

Hardware complications are potentially correctable.[8)9)12)13)] A lead fracture may be suspected when the impedance is abnormally high and the current drain is abnormally low. Lead migration occurs due to malfunction of anchoring devices. Many migrations occur while securing the lead by using fluoroscopy before and after lead testing. Fluoroscopy can aid in ensuring a proper lead position prior to closing the scalp incision. In our experience, placement of the connector in the supraclavicular location allows more motion of the lead with head turning. Placement of the connector underneath the scalp in the paramastoid area minimizes the torque produced between the in-line extension lead and the DBS lead. Battery failure can make an abrupt rebound of symptoms.[2)3)5)] We did not met this problem through regular check-up.

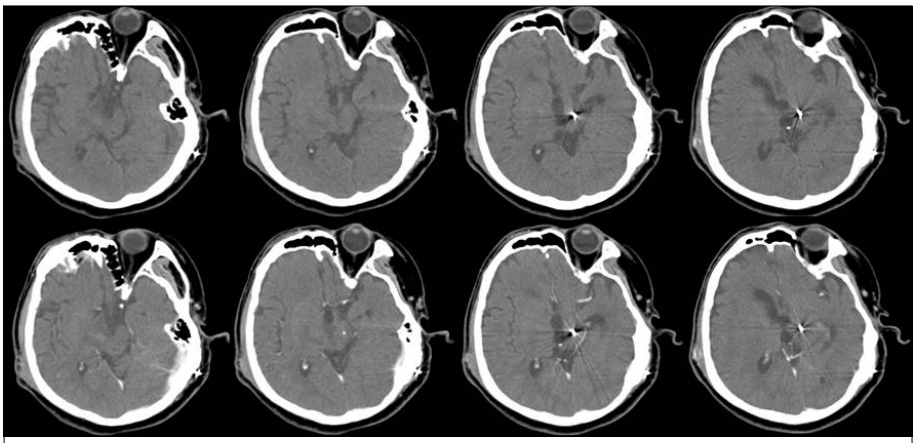
Device related infection is common. Erythema, calor, induration, tenderness, or drainage from operative sites should be evaluated as soon as possible. The incidence

of postoperative hardware-related infection requiring further surgery was 4.5% in other group.[15)16)] Certain groups have suggested that a higher delayed infection rate is associated with frontal incisions directly above the burr hole site[14)] and the use of bulky first-generation hardware connector devices. The management of hardware-related infections has not been standardized. Systemic disease, smoking, and scalp thickness are likely to be important risk factors in development of infection and erosion.[6)] Several groups have reported that infections at any part of the device were ultimately treated with removal of all hardware in most cases, despite initial attempts at more localized treatment.[10)] The Medtronic DBS system consists of three components (lead, lead extender, and IPG), any one of which can be removed and replaced independently of the other components. When an infection seems clinically to involve device components other than the lead, it is clearly desirable to adopt a management strategy that avoids further intracranial stereotactic surgery for lead replacement because replacement of this component involves the most risk and surgical time. Partial hardware removal strategy is more likely to succeed when the pathogen is an organism other than Staphylococcus aureus.[7)]

Fig. 7. A 50-year old man with PD took bilateral Gpi DBS. 14 months later, He admitted with high fever. Erosion with exposure of connector was found. We did debridement and primary closure and intravenous antibiotics therapy during 4weeks.

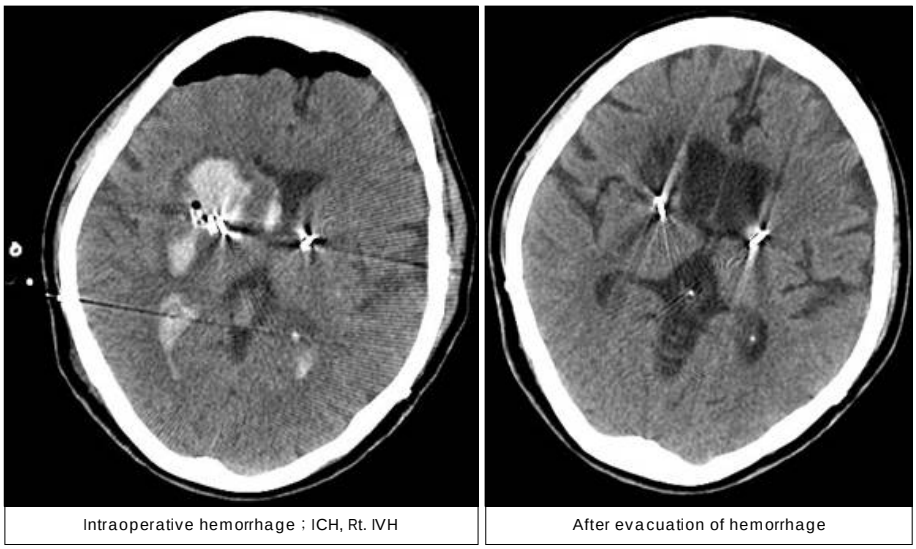


9 Mo. Later, Immediate Postop CT



6 wks after IV antibiotics therapy

Fig. 6. A 63-year old man presented with 26 history of PD underwent bilateral Gpi DBS. 9 months later, he was admitted with high fever, pus discharge and redness at all over cables. In culture, staphylococcus aureus was found. We removed right side system immediately and did intravenous antibiotics therapy for 6 weeks. We confirmed no residual pus on the computed tomography.



Intraoperative hemorrhage : ICH, Rt. IVH | After evacuation of hemorrhage

Fig. 8. Acute intracranial hemorrhage and intraventricular hemorrhage in a 56-year old woman with PD was noted after placement of bilateral thalamic DBS. She underwent craniotomy and evacuation of hematoma immediately. The patient remains under good tremor control without neurologic deficit.

Quick actions to suspected infections can salvage intracranial leads in select series. Also, erosions can occur over the DBS wire connections, the burr hole cap, or the pulse generator. These should be addressed surgically to avoid future infection.

A recent report of DBS failures revealed approximately one half of referred leads were suboptimally placed.[11] Although there exists controversy over the use of MRI in post-DBS cases, there are thousands of patient experiences worldwide that have been successful using a 1.5T scanning device, a head receive coil, avoiding scanning in the presence of an abdominal impulse generator. If the anatomical location appears outside a reasonable target region, and the clinical benefit is unacceptable, or if alternatively side effects occur at low levels of stimulation, replacement of the intracranial lead should be considered. Perioperative and delayed hematoma was also reported in other group.[1] In this cases, permanent complication was reported but patients was recovered without complication in our cases.

CONCLUSION

Complication due to the hardware are not life-threatening but are expensive in economic terms and in terms of patient suffering. The most common complications were related to the electrode connector's infection. Our management strategy for device-related infection emphasized early surgical treatment. As experience is gained, novel ways of avoiding complications and treating patients with complications will be developed. DBS device manufacturers need to create the next generation of DBS devices, and surgeons who implant DBS electrodes need to develop innovative techniques.

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