Surgical Neurology International

SNI: Stereotactic, a supplement to Surgical Neurology International

OPEN ACCESS

For entire Editorial Board visit : http://www.surgicalneurologyint.com

Editor
Antonio A. F. DeSalles, MD
University of California, Los Angeles, CA, USA

Dilemmas surrounding the diagnosis of deep brain stimulation electrode infection without associated wound complications: A series of two cases

Ha Son Nguyen, Ninh Doan, Michael Gelsomino, Saman Shabani, Wade Mueller

Department of Neurosurgery, Medical College of Wisconsin, Milwaukee, WI, USA

E-mail: *Ha Son Nguyen - hsnguyen@mcw.edu; Ninh Doan - ndoan@mcw.edu; Michael Gelsomino - mgelsomino@mcw.edu; Saman Shabani - sshabani@mcw.edu; Wade Mueller - wmueller@mcw.edu
*Corresponding author

Received: 21 August 15 Accepted: 11 December 15 Published: 10 February 16

Abstract

Background: When wounds are benign, diagnosis of deep brain stimulation (DBS) electrode infection and associated intraparenchymal infection can be challenging. Only a couple, such cases exist in literature. Since infections of the central nervous system can be life-threatening, prompt diagnosis is necessary to prevent neurological injury. Employed within the appropriate context, magnetic resonance imaging (MRI) of the brain, as well as laboratory data and clinical presentation, may help guide diagnosis.

Case Descriptions: Case 1 - A 55-year-old male with bilateral DBS electrodes and generators (49 days from last procedure), who presented with confusion and fever. Pertinent positive laboratory was white blood cell 20.5K. MRI of the brain showed edema with enhancement along the right DBS electrode. Wound exploration revealed gross purulence in the subgaleal space. The entire system was removed; cultures from subgaleal space revealed *Propionibacterium acnes*; cultures from electrode were negative. The patient was sent home on antibiotics. Case 2 - A 68-year-old male with a right DBS electrode (11 days from placement), who presented after an unwitnessed fall, followed by confusion and amnesia. Pertinent laboratory examinations were negative. MRI of the brain showed edema with enhancement along the DBS electrode. Wound exploration revealed no infection. The DBS system was left in place; final cultures were negative; no antibiotics were prescribed. Repeat MRI showed resolving fluid-attenuated inversion recovery (FLAIR) signal and contrast enhancement.

Conclusions: Contrast enhancement, T2 FLAIR, and diffusion weighted imaging are influenced by postoperative changes. Caution is stressed regarding dependence on these features for acute diagnosis of infection and indication for electrode removal. Timing of the imaging after surgery must be considered. Other factors, such as systemic signs and abnormal laboratory data, should be evaluated. Based on these guidelines, retrospectively, the patient in Case 2 should not have been rushed for a wound exploration; close observation with serial imaging and laboratory data may have prevented an unnecessary procedure.

Key Words: Cerebral infection, contrast enhancement, deep brain stimulation, edema, fluid attenuated inversion recovery, magnetic resonance imaging

Access this article online
Website: www.surgicalneurologyint.com
DOI: 10.4103/2152-7806.176133
Quick Response Code:

How to cite this article: Nguyen HS, Doan N, Gelsomino M, Shabani S, Mueller W. Dilemmas surrounding the diagnosis of deep brain stimulation electrode infection without associated wound complications: A series of two cases. Surg Neurol Int 2016;7:S121-4.
http://surgicalneurologyint.com/Dilemmas-surrounding-the-diagnosis-of-deep-brain-stimulation-electrode-infection-without-associated-wound-complications:-A-series-of-two-cases/

INTRODUCTION

A dreaded complication of deep brain stimulation (DBS) is hardware infection, which may entail additional hospital expenses, hardware removal, and delay of DBS therapy. Infection rates associated with DBS varies from 0% to 15% in various prior studies.[2,3,6] Infections are frequently discovered at the site of the internal pulse generator (IPG), at the connector site, or at the scalp overlying the burr hole for the electrode. These are apparent based on edema, erythema, pain/tenderness, or drainage over the affected location. When surgical wounds are benign, diagnosis of a DBS electrode infection and associated intraparenchymal infection can be challenging. The literature only provides a few cases with this clinical scenario. We report a series of two additional patients with concerns for electrode infection; both underwent wound exploration, and one was discovered to have an infection. Since infections of the central nervous system (CNS) can be life-threatening, prompt diagnosis is necessary to prevent neurological injury. Employed within the appropriate context, magnetic resonance imaging (MRI) of the brain, as well as systemic inflammatory markers and clinical presentation, may help guide diagnosis.

CASE REPORTS

Patient 1

A 55-year-old male, postoperative day 86 (left subthalamic nucleus [STN] electrode), postoperative day 58 (right STN electrode), and postoperative day 49 (bilateral IPG placement), presented to the Emergency Department (ED) with confusion. He was found to have a fever of 102 F in the ED. Pertinent laboratory examinations included lactate 2.0 mmol/L (normal range 0–2.2 mml/L), C-reactive protein (CRP) 1.0 mg/dL (normal range 0–0.5 mg/dL), erythrocyte sedimentation rate (ESR) 17 mm/h (normal range 0–19 mm/h), white blood cell (WBC) 20.5K, UA negative, blood cultures negative, and chest X-ray negative. All incisions were clean, dry, and intact without concerns for infection. CT of the head demonstrated no acute findings. MRI of the brain with contrast demonstrated vasogenic edema along both DBS electrodes, right greater than left, with enhancement tracking around the right DBS electrode [Figure 1]. Wound exploration was recommended. Once the cranial incision was opened, gross purulence was discovered in the subgaleal space. The postauricular incision was then opened, and no purulence was discovered. The wire was cut at this location and the electrode was removed. The chest wound was explored, and the generator was removed. Cultures for the subgaleal space revealed *Propionibacterium acnes*; cultures from the electrode were negative. The patient was sent home on prolonged intravenous antibiotics.

Patient 2

A 68-year-old male, postoperative day 11 (right STN electrode), presented after an unwitnessed fall, followed by confusion and amnesia. He denied fevers, chills, weakness, paresthesias, changes in medications, prior syncopal episodes, or falls. Pertinent laboratory examinations included WBC 9.5, UA negative, ESR 30 mm/h, CRP 1.2 mg/dL, and chest X-ray negative. All incisions were clean, dry, and intact without concerns for infection. CT of the head demonstrated no acute findings. MRI of the brain with contrast demonstrated abnormal edema and enhancement along the DBS electrode [Figure 2]. Wound exploration was recommended. There was no evidence of infection in the subgaleal space. Cultures were taken. The burr hole cap was removed and the hinge was opened. No signs of infection were noted below the burr hole cap or below the hinge. Additional cultures were obtained. The hinge and cap were re-attached after copious irrigation. Final cultures were negative for bacteria. No antibiotics were prescribed. Follow-up MRI showed resolving T2 fluid attenuated inversion recovery (FLAIR) signal and enhancement.

DISCUSSION

Imaging is a critical component for the diagnosis of an underlying infection, especially when surgical wounds

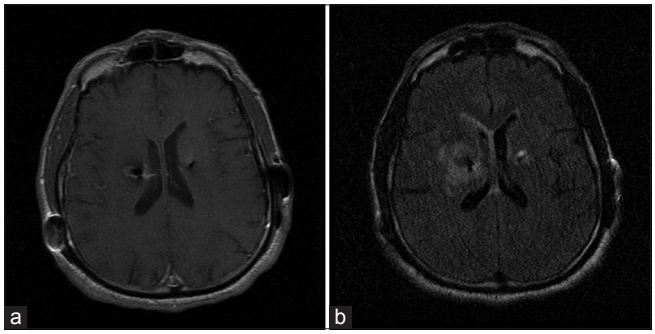

Figure 1: Magnetic resonance imaging T1 with contrast (a) and fluid attenuated inversion recovery (b) sequences for patient 1

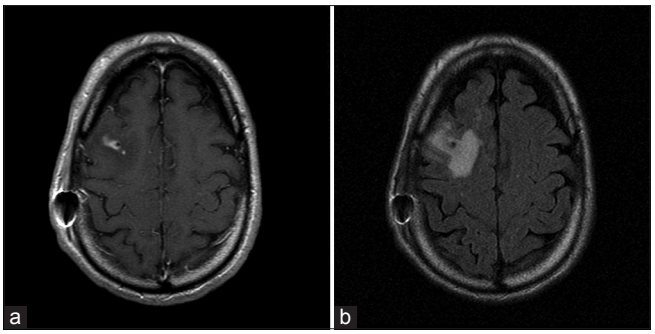

Figure 2: Magnetic resonance imaging T1 with contrast (a) and fluid attenuated inversion recovery (b) sequences for patient 2

are benign. In particular, MRI has become a diagnostic fixture for CNS infection, especially regarding T1 with contrast, T2 FLAIR, and diffusion-weighted imaging (DWI). However, these protocols may be confusing and misleading, especially during the postoperative period. In particular, contrast enhancement after craniotomy can be variable, appearing as early as 17 h to 5 days postoperatively within nonneoplastic brain parenchyma along surgical margins; moreover, the imaging feature can persist up to 14–29 days postoperatively, though data are limited to 1 month in various studies.[7,8,12] A confounding factor for contrast enhancement during postoperative imaging is methemoglobin at the operative site. Methemoglobin (a representation of subacute hemorrhage) is hyperintense on T1 and tends to develop between postoperative days 7 and 21 but can manifest as early as postoperative day 1.[7] Besides methemoglobin, other etiologies obscure assessment of contrast enhancement on postoperative imaging, including angiogenesis, active inflammation, cerebral ischemia, and reactive hyperemia.[13]

DWI has become a standard sequence for the differentiation of brain abscess from other ring-enhancing lesions.[16] However, the sequence is also affected after surgical intervention as it has a high false-negative rate for infection after neurosurgical procedures.[5] On the other hand, a positive finding may simply represent postsurgical changes. Smith *et al.*[14] noted that an abnormality on DWI can occur after resection of newly diagnosed gliomas; this finding was typically supplanted by contrast enhancement on follow-up imaging (ranging between 15 and 198 days postoperatively) and ultimately demonstrated encephalomalacia.

T2/FLAIR signal can be associated with infection or hemorrhage but may also be transient without clinical consequences. Englot *et al.*[4] reported 15 patients with T2 signal along a DBS electrode during routine postoperative MRI to evaluate electrode placement. When these patients were compared to those without T2 signal, there was no statistical relationship based on the number of microelectrodes passes/DBS electrode passes, age, gender, side of implantation, target, diagnoses, or active stimulation. Notably, T2 signal may be related to timing between surgery and MRI, as those with T2 signal obtained imaging later than those who did not exhibit T2 signal.[4] DWI sequences were obtained in five patients while contrasted sequences were obtained in three patients; none of these sequences had positive findings concerning for infection. Postulated etiologies include vasogenic edema in the setting of an inflammatory response, local tissue trauma from electrode placement, and hardware-related neurotoxicity.

Inflammatory indices including CRP and ESR have been employed to monitor for infection. However, these indices frequently elevate postoperatively; based on literature regarding orthopedic procedures including spine surgery, these values may take 14 days to 90 days to normalize to preoperative levels.[1,9,11] Unfortunately, no significant data exist for cranial procedures. Consequently, a single high value after surgery may not indicate infection. On the other hand, a spike during serial sampling may foretell an infection.

For the rare DBS electrode infections reported in literature without associated wound complications, MRI findings have been inconsistent. Merello *et al.*[10] reported a patient who presented with confusion and apathy 6 months after the last DBS surgery. An MRI brain demonstrated T2 signal around the electrode but no enhancement. The electrode was withdrawn and brain biopsies were sent for cultures, which were positive for *Candida parasilosis*. Vanderhorst *et al.*[15] reported a patient who presented 3 days after DBS surgery with fevers and confusion. MRI brain demonstrated a 2 cm × 1.7 cm × 2.4 cm ring-enhancing lesion around the electrode, with surrounding T2 signal. A right frontal craniotomy revealed no evident scalp or subgaleal infection; reddish-gray material was found subcortically, where cultures grew *Enterobacter aerogenes*. Both cases illustrated that suspicion of intraparenchymal infection must be maintained, even without wound complications. However, MRI contrast enhancement was inconsistent between these two cases. Unfortunately, no details existed regarding DWI.

Considering the influence of postoperative changes to MRI sequences, as well as systemic signs and laboratory data, prompt wound exploration was reasonable for patient 1. He exhibited fevers with an elevated WBC count. Other infectious workup was negative. His last cranial procedure was 58 days prior; consequently, the MRI findings (contrast enhancement and T2 FLAIR) was likely reliable for infection. On the other hand, retrospectively, patient 2 should not have been rushed for a wound exploration. He did not exhibit systemic signs. Moreover, he was only 11 days from electrode placement, where postoperative changes can confound MRI findings and inflammatory indices. Based on the prior literature, contrast enhancement may be benign up to 1 month postoperatively, while T2 FLAIR signal and DWI can remain variable. Table 1 compares our patients to the two patients from literature noted above, as well as suggesting criteria for infection.

CONCLUSIONS

Contrast enhancement, T2 FLAIR, and DWI are influenced by postoperative changes. Caution is stressed regarding dependence on these features for acute diagnosis and indication for electrode removal. Timing

Table 1: A comparison between our patients and the patients from literature

	Patient 1*	Patient 2	Vanderhorst *et al.*[15]*	Merello *et al.*[10]*	Criteria for infection
Clinical presentation					
Fever	+	−	+	−	+
Local pain	−	−	−	−	+/−
Confusion	+	+	+	+	+/−
Failure of stimulation	N/A	N/A	N/A	+	+
Laboratory**					
WBC (K)	20.5	9.5	15	N/A	>10
CRP (1.0 mg/dL)	1	1.2	N/A	N/A	+/−
ESR (mm/h)	17	30	N/A	N/A	+/−
MRI***					
Imaging (timing after last lead implantation)	58 days	11 days	10 days	+8 months	>30 days
DWI	N/A	N/A	N/A	N/A	+/−
T2	+	+	+	+	+/−
Flair	+	+	+	+	+/−
T1 contrast enhancement	+	+	+	−	+/−

*Patients with infection, **ESR and CRP likely more reliable when obtained further out from surgery, ***Imaging characteristics likely more reliable when evaluated >30 days from surgery. N/A: Not available, ESR: Erythrocyte sedimentation rate, CRP: C-reactive protein, WBC: White blood cell, DWI: Diffusion-weighted imaging

of the imaging after surgery must be considered, as postoperative changes can influence all three sequences. Other factors, such as systemic signs (fever/chills) and abnormal laboratory markers (elevated WBC, ESR, and CRP), should be evaluated. Based on these guidelines, retrospectively, patient 2 should not have been rushed for a wound exploration; close observation with serial imaging and laboratory markers may have prevented an unnecessary procedure.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Aono H, Ohwada T, Kaneko N, Fuji T, Iwasaki M. The post-operative changes in the level of inflammatory markers after posterior lumbar interbody fusion. J Bone Joint Surg Br 2007;89:1478-81.
2. Bhatia S, Zhang K, Oh M, Angle C, Whiting D. Infections and hardware salvage after deep brain stimulation surgery: A single-center study and review of the literature. Stereotact Funct Neurosurg 2010;88:147-55.
3. Bjerknes S, Skogseid IM, Sæhle T, Dietrichs E, Toft M. Surgical site infections after deep brain stimulation surgery: Frequency, characteristics and management in a 10-year period. PLoS One 2014;9:e105288.
4. Englot DJ, Glastonbury CM, Larson PS. Abnormal T2-weighted MRI signal surrounding leads in a subset of deep brain stimulation patients. Stereotact Funct Neurosurg 2011;89:311-7.
5. Farrell CJ, Hoh BL, Pisculli ML, Henson JW, Barker FG 2nd, Curry WT Jr. Limitations of diffusion-weighted imaging in the diagnosis of postoperative infections. Neurosurgery 2008;62:577-83.
6. Fenoy AJ, Simpson RK Jr. Management of device-related wound complications in deep brain stimulation surgery. J Neurosurg 2012;116:1324-32.
7. Forsyth PA, Petrov E, Mahallati H, Cairncross JG, Brasher P, MacRae ME, *et al.* Prospective study of postoperative magnetic resonance imaging in patients with malignant gliomas. J Clin Oncol 1997;15:2076-81.
8. Henegar MM, Moran CJ, Silbergeld DL. Early postoperative magnetic resonance imaging following nonneoplastic cortical resection. J Neurosurg 1996;84:174-9.
9. Kong CG, Kim YY, Park JB. Postoperative changes of early-phase inflammatory indices after uncomplicated anterior cervical discectomy and fusion using allograft and demineralised bone matrix. Int Orthop 2012;36:2293-7.
10. Merello M, Cammarota A, Leiguarda R, Pikielny R. Delayed intracerebral electrode infection after bilateral STN implantation for Parkinson's disease. Case report. Mov Disord 2001;16:168-70.
11. Park KK, Kim TK, Chang CB, Yoon SW, Park KU. Normative temporal values of CRP and ESR in unilateral and staged bilateral TKA. Clin Orthop Relat Res 2008;466:179-88.
12. Sato N, Bronen RA, Sze G, Kawamura Y, Coughlin W, Putman CM, *et al.* Postoperative changes in the brain: MR imaging findings in patients without neoplasms. Radiology 1997;204:839-46.
13. Smirniotopoulos JG, Murphy FM, Rushing EJ, Rees JH, Schroeder JW. Patterns of contrast enhancement in the brain and meninges. Radiographics 2007;27:525-51.
14. Smith JS, Cha S, Mayo MC, McDermott MW, Parsa AT, Chang SM, *et al.* Serial diffusion-weighted magnetic resonance imaging in cases of glioma: Distinguishing tumor recurrence from postresection injury. J Neurosurg 2005;103:428-38.
15. Vanderhorst VG, Papavassiliou E, Tarsy D, Shih L. Early brain abscess: A rare complication of deep brain stimulation. Mov Disord 2009;24:1395-7.
16. Xu XX, Li B, Yang HF, Du Y, Li Y, Wang WX, *et al.* Can diffusion-weighted imaging be used to differentiate brain abscess from other ring-enhancing brain lesions? A meta-analysis. Clin Radiol 2014;69:909-15.