

## Clinical Study

## Delayed awakening in dystonia patients undergoing deep brain stimulation surgery

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## ARTICLE INFO

## Article history:

Received 16 June 2009

Accepted 29 November 2009

## Keywords:

Delayed awakening

Dystonia

Propofol

## ABSTRACT

We aimed to identify the incidence, duration and causes of delayed emergence from anesthesia in patients with dystonia undergoing surgery for deep brain stimulation (DBS) placement. A retrospective review of patients with dystonia who underwent DBS placement was conducted and the following characteristics were noted: age, gender, comorbid conditions, American Society of Anesthesiologists classification, anesthetic agents used, amount of initial dose, amount of infusion dose, duration of the infusion and the time needed for emergence. Twenty-four patients underwent 33 DBS procedures for dystonia. Propofol was administered to 21 patients, in 29 of the 33 procedures. Dexmedetomidine was administered to three patients, in four procedures. The average propofol loading dose was 0.7 mg/kg, and the infusion rate was 80 µg/kg per minute (min), for an average duration of 89 min. The average time of emergence was 36 min. Only 31% of patients emerged from propofol anesthesia during the expected time frame, 69% of patients had some degree of delayed emergence, and 24% had a significant delay in emergence. Delayed emergence was more common in younger patients due to the higher loading doses these patients received. This study shows a 69% incidence of delayed emergence in dystonia patients undergoing DBS surgery. It also suggests an association between delayed emergence and younger patients who receive higher loading doses. A possible cause of delayed emergence is excessive anesthetic potentiation of the low output pallidal state in dystonia which may depress the pallido-thalamo-cortical circuitry. Delayed emergence could also result from depression of the previously affected ventral pallidal inputs to the septo-hippocampal system that mediates general anesthesia and awareness. Complex neurotransmitter disturbances may also be involved.

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## 1. Introduction

Dystonia is a clinical syndrome causing repetitive muscle contractions and abnormal posture. Deep brain stimulation (DBS) surgery provides an alternative for patients for whom medical treatment is unsuccessful.<sup>1–3</sup> Anesthetic management during DBS surgery includes a period of sedation followed by a period during which patients are required to be awake and cooperative. This is important for physiological targeting using microelectrode recordings (MER) to ensure accurate lead placement.<sup>2</sup> Delayed emergence from anesthesia after neurosurgical procedures has been reported for several reasons such as residual anesthetic effect, metabolic derangements or intra-cerebral events such as hemorrhage or embolism.<sup>4–11</sup> Delayed awakening in dystonia patients in the ab-

sence of these factors has not been previously reported; however, we identified delayed emergence in the absence of any complications. We also report the incidence, duration and possible indicators of delayed emergence from anesthesia in dystonia patients during DBS placement.

## 2. Methods

A retrospective chart review identified adult patients with dystonia who underwent DBS at the Cleveland Clinic between March 2003 and December 2006. Particular attention was paid to the neurologist's pre-procedure notes, which included current medications and co-morbid conditions, the anesthetic chart, the neuro-monitoring procedure note, and subsequent progress notes identifying any intra-operative or post-operative complications. Each patient's age, gender, co-morbid conditions, current medications, and American Society of Anesthesiologists (ASA) classification were

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documented as well as the anesthetic agent used, amount of initial dose, amount of infusion dose, and duration of the infusion. Standard statistical methods including the Student's *t*-test were used for statistical analysis.

### 2.1. DBS surgical technique for dystonia patients

DBS for dystonia patients primarily involved stereotactic frame placement, MRI and CT scan acquisition, stereotactic navigation systems, and neurophysiological mapping techniques. The target of DBS placement in dystonia was the globus pallidus internus (GPi) (Fig. 1). Under local anesthesia and intravenous (iv) sedation, an incision was made and a burr hole placed on the entry point. Once the burr hole was completed, iv sedation was ceased and the patient was allowed to wake completely before MER commenced. The DBS electrode (Medtronic, Minneapolis, MN, USA) was placed at the final target.

### 2.2. DBS anesthetic technique for dystonia patients

The head pins and frame were placed under local anesthesia. Standard ASA monitors were used and oxygen was administered by nasal cannula. An asleep-awake-asleep technique was used for all patients; this included an initial bolus dose of the sedation medication followed by a continuous infusion. During this time the neurosurgical team performed the initial exposure, incision and burr hole. Once this was done, sedation was stopped and the patient awoke for MER, as described in Section 2.1. We recorded the time at which the infusion was stopped and determined the time when the patient was considered awake to perform initial testing from the neurophysiologist's procedure note. This time difference was designated as the time taken for the patient to emerge from sedation. A continuous infusion of sedation medication was used at the time of closure (the end of surgery).

## 3. Results

Thirty-five patients underwent DBS placement for dystonia during the study. Three pediatric patients (aged less than 18 years), three adult patients whose charts were incomplete or unavailable,

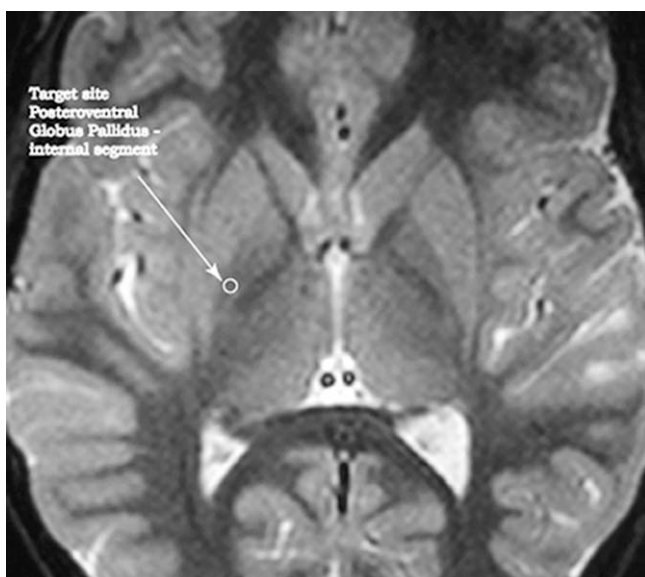


Fig. 1. Inversion recovery axial MRI showing the postero-ventral globus pallidus internus, the target site for deep brain stimulation lead placement in dystonia.

and five adult patients who underwent the procedure with a general anesthetic were excluded. The remaining 24 patients underwent 33 procedures in which an asleep-awake-asleep technique was used. Dexmedetomidine was used in four of the procedures and propofol was used in 29 procedures. Each procedure was considered as a different unit in patients who underwent staged placements that were separated by more than 3 months. Patient demographics are outlined in Table 1.

### 3.1. Propofol group

The average bolus dose of propofol was 0.74 mg/kg (standard deviation [SD]  $\pm$  0.48), the average duration of the infusion was 89 min (SD  $\pm$  43), and the mean infusion dose was 75.3  $\mu$ g/kg per min (SD  $\pm$  36.8). The mean time for awakening was 35.2 min (SD  $\pm$  16.0). Patients within the propofol group were further stratified according to the time taken for emergence from anesthesia. We divided patients into three groups: (i) expected time (ET), in which patients awoke within 25 min; (ii) moderate delay (MD), in which patients awoke between 25 and 39 min; and (iii) delayed awakening (DA), in which patients took 40 min or more to awaken. Nine of 29 (31%) patients awoke within 25 min, 13 of 29 (45%) awoke between 26 and 39 min, and seven of 29 (24%) awoke after 40 min or more (Table 2). Further analysis of the groups, based on age, revealed that the ET group was older than the DA group ( $46.1 \pm 16.3$  years versus [v.]  $35.1 \pm 12.0$  years) and this difference was statistically significant ( $p = 0.049$ ). The initial loading dose of propofol was different in each group. The DA group loading dose was significantly larger ( $1.13 \pm 0.51$  mg/kg) than that of the ET group ( $0.50 \pm 0.22$  mg/kg) or the MD group ( $0.69 \pm 0.48$  mg/kg) and this difference was also statistically significant ( $p = 0.024$ ). There was no difference in the infusion doses used per group ( $p = 0.87$ ) or the duration of sedation in each group ( $p = 0.93$ ).

### 3.2. Dexmedetomidine group

The initial bolus for patients who received dexmedetomidine was 1 mg/kg, and the mean infusion dose was 0.5 mg/kg per hour for an average of 152 min (one surgery was prolonged and lasted almost 5 hours). The average awakening time was 48 min. One patient woke up in 10 min; the other three took more than 40 min. Due to the smaller number of patients, they were not included in statistical analysis.

### 3.3. Complications

Intraoperatively, three patients had at least one episode of hypertension that required treatment during the awake phase of the procedure. Two patients had clinically asymptomatic intracerebral hemorrhages diagnosed on post-operative CT scans and both of these patients had thrombocytopenia pre-operatively. There were no anesthesia-related complications.

Table 1

Patient demographics and details of dose, infusion, duration and emergence time in the propofol and dexmedetomidine groups

	Propofol	Dexmedetomidine
Number of patients	29	4
Age (years)	$42.172 \pm 15.200$	$54.0 \pm 18.3$
Male/female	14/15	2/2
Weight (kg)	$72.207 \pm 17.500$	$79.00 \pm 4.69$
Dose (mg/kg)	$0.743 \pm 0.481$	1.0
Infusion (mcg/kg/min)	$75.345 \pm 36.800$	$0.5 \pm 0.2$
Time (min)	$89.310 \pm 43.800$	$152 \pm 88$
Awake (min)	$35.241 \pm 16.100$	$48 \pm 29$

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