Contraversive Eye Deviation During Stimulation of the Subthalamic Region

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Video

Abstract: Contraversive eye deviation (CED) is most often observed intraoperatively during subthalamic nucleus implantation for Parkinson’s disease and considered to result from wrong electrode positioning. We report on a woman, bilaterally implanted in the subthalamic nucleus for severe Parkinson’s disease disclosing long-lasting CED only when the stimulators were activated separately. Clinical examination and eye movements recording in this patient showed that CED occurred when stimulation was applied at the site and at similar intensity used for the best antiparkinsonian effect. These results suggest that the subthalamic area may be involved in orienting movements, either through the subthalamic nucleus itself or the fibers from the Frontal Eye Fields. Interestingly, this report shows that CED may be corrected by bilateral stimulation and that CED may not necessarily implicate electrode repositioning. © 2007 Movement Disorder Society

Key words: Parkinson’s disease; deep brain stimulation; subthalamic nucleus; eye movements; saccades

Although contraversive eye deviation (CED) is frequently induced intraoperatively during placement of subthalamic nucleus (STN) stimulating electrodes,1 the phenomenon has never been formally described in the literature. Nor has a patient with STN stimulators ever been reported to experience CED in the chronic setting. Such reports may be lacking because many operators consider CED as a mark of poor electrode positioning, prompting them either to reposition the electrode assembly or select different contacts for chronic use. Additionally, bilateral stimulation may counterbalance the eye deviation induced on one side and result in a under observation of the phenomenon. We report on the case of a patient in whom contacts lying within the STN and slightly above the nucleus produced CED, both intraoperatively and many years later.

CASE REPORT

A 36-year-old woman was bilaterally implanted into the STN for severe Parkinson’s disease (PD) in 2000. Implantation was based on electrophysiological recording with five microelectrodes separated by 2 mm from each other and on the evaluation of the stimulation-induced effects under local anesthesia.2 Intraoperatively, CED was induced on each side during stimulation by the microelectrodes that presented the best antiparkinsonian effect, between the dorsal limit and 1 mm above the ventral limit of the STN defined by electrophysiological activity. With monopolar stimulation, antiparkinsonian effect was achieved at 1 mA on both sides and CED occurred at 2 mA on the right and 1 mA on the left. In the chronic setting, the best antiparkinsonian effect was achieved with monopolar stimulation (60 μs, 130 Hz) at 3.3 V on the right contact 2 and 3.5 V on the left contact 1 of a quadripolar electrode (DBS-3389, Medtronic, Minneapolis, MN). Postoperative MRI confirmed that these contacts were located inside the STN (Fig. 1). Antiparkinsonian medication was reduced by 87%. The UPDRS scores part III with medication (Med) and/or bilateral stimulation (Stim) were: Med OFF/Stim OFF: 68.5; Med ON/Stim OFF: 35.5; Med OFF/Stim ON: 7.5; Med ON/Stim ON: 7.5. The patient never experienced CED when both stimulators were operating and did not report any ocular motor complaints. Three years after surgery, CED could however be demonstrated if the stimulators were activated separately (See Video legend for more precise description of the phenomenon). In both directions of CED, intense blinking was observed. CED was accompanied by contraversive head deviation with stimulation of left contacts. Attempts to correct head deviation as well as eye deviation was very effortful and the correction remained incomplete. On both sides, the contact on which CED was observed at the lowest stimulus voltages coincided with the contact of lowest threshold for the antiparkinsonian effects (Table 1).

Eye movements were recorded in darkness after antiparkinsonian medication was withdrawn for 12 hours,
without, with unilateral or with bilateral stimulation on the effective contacts. Eye position was recorded using two infrared cameras held on a helmet (Eye Link I, SMI). Head movements were prevented using a chin rest. Any residual change of head position was monitored by helmet mounted infrared camera. With unilateral stimulation, both eyes clearly deviated to the opposite side. The deviation, which was roughly conjugate, was the consequence of a succession of eye movements not exceeding 5° in amplitude and corresponding to normal saccades according to their velocity and duration (Fig. 2). However, as shown on the video and Figure 2, during unilateral stimulation, the intense blinking of the patient did not allow us to characterize precisely the eye movement. Interestingly, as soon as a low voltage stimulus was applied concurrently on the contralateral contact, the eyes returned to a straight-ahead position.

DISCUSSION

We report on a woman, bilaterally implanted in the STN for severe PD, disclosing long-lasting CED only when the stimulators were activated separately. The patient, as other patients experiencing CED, reported eye deviation as an unpleasant feeling. With high stimulation on the left side, the patient presented with right head deviation that could be attributed to a more global orienting system including eyes and head movements. Attempts to correct head deviation as well as eye deviation was very effortful and the correction remained incomplete. With some aspects, increased eye blinking seemed to be a direct consequence of stimulation but, on the other hand, they may be attributed to uncomfortable gaze deviation and patient’s effort to fight against CED.

Different data suggest that in this patient, CED may result from stimulation of the STN itself. During implantation, CED occurred on both sides in the electrophysiological area defining the STN, at the same position where the best antiparkinsonian effect was observed and with similar stimulation intensity. In chronic condition, CED could still be demonstrated if the stimulators were activated separately, with similar voltages and on the contacts where the best motor response was observed. In addition, adding a small concurrent stimulation on the contralateral effective contact was sufficient to inhibit the ocular deviation. The involvement of STN in the contralateral gaze control is supported by the existence of direct projections from the Frontal Eye Fields and by the disclosure of preoculomotor activity in relation to visually cued and self-paced saccades in subthalamic

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<th>Electrode</th>
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<td>3</td>
<td>4.3 V</td>
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<tr>
<td>2</td>
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Face contraction indicates tonic contractions of the contralateral face, CED indicates contraversive eye deviation. * indicates that no effect was observed up to 5 volts.
neurons. In monkeys, unilateral GABAergic inactivation induced contralateral gaze deviation when performed inside but not outside the nucleus. On the other hand, CED could be induced by current diffusion outside the STN. Indeed, in chronic condition, CED was also induced at sites dorsal to the ones providing the best antiparkinsonian effects but with higher voltages. Stimulation outside the nucleus could then involve fibers of passage as it has been reported to explain CED during stimulation of the GPi. Current diffusion to fronto-collicular or fronto-mesencephalic projections could then be incriminated since these fibers are adjacent to the internal capsule and close to the STN. The threshold voltages inducing CED remained however lower than those inducing facial contractions on the contacts inducing the best antiparkinsonian effect. In an unicist explanation, we could then hypothesize that CED may be due to stimulation of fibers from the Frontal Eye Fields as they enter the STN. This would explain why we obtained CED inside and above the nucleus as well why low voltages applied in the nucleus on the other side may correct CED.

The ocular motor subsystem mediating CED in our patient remains speculative. Induced eye deviation in our patient seemed to result from the succession of apparently normal saccades toward the contralateral hemisphere. It has been shown that memorized and reflexive saccades were improved by subthalamic HFS. We could hypothesis that, in some patients, stimulation may have an exaggerated effect and may induce the occurrence of intrusive contralateral saccades. Since high frequency stimulation is thought to inhibit the STN, a disfacilitation of the SNpr, and an associated disinhibition of the ipsilateral Superior Colliculus (SC) would follow. As the SC is involved in contralateral gaze saccades, subthalamic HFS would thus generate gaze deviation to the contralateral hemisphere. The resulting imbalance of activity between the two SC would also generate a unidirectional attentional and/or oculomotor drive which would prevent the patient from looking back to the center until subthalamic HFS is turned off or is counterbalanced by contralateral subthalamic HFS.

Though the exact mechanism of CED during stimulation of the subthalamic area remains under debate, this case shows that CED was only induced by experimental unilateral stimulation and the patient never complained of it during usual bilateral chronic stimulation. Therefore, during STN electrode placement procedures, a demonstration of CED at a contact does not, of itself, warrant repositioning the electrode assembly or eliminating the use of the contact.

FIG. 2. Change in eye position (A) elicited by unilateral right stimulation (contact 2; 3.4 V) in the absence of fixation target. Horizontal eye position corresponds to the average of right and left eye positions and is expressed in degrees. 800 ms after stimulation onset (figured by vertical dashed line and an arrow), stimulation induced a staircase-like eye deviation with individual steps frequently associated with eye-blink. Vertical lines are artefacts corresponding to eye-blink. A magnification of the eye position trace with additional horizontal eye velocity is figured below (B). Eye velocity is expressed in degrees/second (scale on the right). Eye step movements without blink reached an average amplitude of 5 degrees, a 40 msec duration and a 100 to 150°/s peak velocity, and thus correspond to normal saccades.

On the video the patient was stimulated on one side then bilaterally and asked to execute voluntary eye movements toward both sides, without presentation of any visual target. The three first segments (A, B, C) show CED to the left induced by stimulation on the right side. Segment A. Unilateral stimulation on the right contact 2 (3.4 V) inducing CED to the left. The patient is unable to gaze to the right until the voltage is decreased to 3.1 V.

Segment B. Unilateral stimulation on the right contact 2 (3.4 V) inducing CED to the left. The patient is unable to gaze to the right until concurrent stimulation (0.5 V) is applied on left contact 1.

LEGENDS TO VIDEO

On the video the patient was stimulated on one side then bilaterally and asked to execute voluntary eye movements toward both sides, without presentation of any visual target. The three first segments (A, B, C) show CED to the left induced by stimulation on the right side.
Segment C. With bilateral stimulation (3.4 V on the right and 0.5 V on the left), the gaze is in straight-ahead position. When left stimulation is stopped, CED to the left resumes.

Segment D. It shows CED to the right induced by stimulation on the left side. The sequence showing CED induced on left contact 1 was of poor quality; we only present CED induced on left contact 2. Increasing unilateral stimulation on the left contact 2 from 4.4 to 4.5 V induces CED to the right and associated contraversive head deviation.

REFERENCES


Clinical and Positron Emission Tomography Findings of Chorea Associated with Primary Antiphospholipid Antibody Syndrome

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Abstract: A fourteen-year-old right-handed male with a history of attention deficit hyperactivity disorder (ADHD) presented with alternating hemichorea. Laboratory findings included elevated anticardiolipin IgG and anti-B2-glycoprotein I IgG, which were consistent with primary antiphospholipid antibody syndrome. Positron emission tomography (PET) imaging revealed altered striatal metabolism in his left putamen while he was exhibiting right-sided hemichorea. His symptoms resolved on prednisone; however, his antiphospholipid antibody profile remained markedly abnormal despite being symptom-free for 26 months. © 2007 Movement Disorder Society

Key words: chorea; antiphospholipid antibody syndrome; PET imaging; steroid.

Although rare, chorea has been reported as a presenting symptom of primary antiphospholipid antibody syndrome.1 Clinical and neuroimaging findings have been reported mainly in adults. The pathophysiology of this neurologic presentation is unknown. However, [F-18]2-fluoro-2-deoxyglucose (FDG)-PET studies suggest al-