■ Subthalamic nucleus and movement preparation

Paradiso et al. recorded a slow, negative, movement-related potential from implanted deep brain electrodes in patients with Parkinson's disease while they performed a self-paced movement. The onset latencies were similar to simultaneously recorded cortical premovement activity, suggesting that the human subthalamic nucleus or nearby structures are active during movement preparation in Parkinson's disease.

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Commentary by Jonathan W. Mink, MD, PhD

The past several years have seen major advances in the treatment of movement disorders with continuous high-frequency deep brain stimulation (DBS) of different targets. DBS of the ventral intermediate thalamus has been shown to be highly effective for treatment of essential tremor and DBS of the globus pallidus or subthalamic nucleus (STN) has been shown to be highly effective for treatment of Parkinson's disease (PD). In addition to the clear therapeutic benefit from this technology, it has provided an outstanding opportunity to study the physiology of motor control and pathophysiology of movement disorders in human subjects. During the implantation procedure, activity can be recorded from a limited sample of neurons at rest and during active movement of awake subjects. After implantation, event-related potentials can be recorded from the implanted electrode leads during movement tasks and other behaviors. This capability provides the opportunity to study event-related potentials of deep brain structures alone or in conjunction with

study of cortical event-related potentials.

The study by Paradiso et al. in this issue of *Neurology* recorded movement-related potentials from the STN of people with PD and has produced some provocative findings. The findings raise questions about the role of different basal ganglia structures in different movement control tasks. There are limited data on the activity of STN neurons in nonhuman primates during performance of highly trained stimulus-triggered movements, and little data on self-initiated movements. The data from nonhuman primates have also been limited to normal animals, whereas the data obtained from humans must come from subjects with neurologic disease. This limits the comparison of the human data with nonhuman primate data.

The study by Paradiso et al. suggests that STN neurons are active early in the generation of voluntary movement. However, there was no significant difference between the timing of motor cortical activity and STN activity. Thus it is not clear from this

study whether there is serial or parallel activation of motor cortex and STN during the production of self-paced movements by people with PD. There are many reasons to question whether the basal ganglia participate in movement initiation per se.¹ Furthermore, it is clear that the physiology of motor control is different between normal and parkinsonian primates.² Thus, the data obtained in PD may have limited relevance to normal motor control. However, they have great relevance for understanding motor control in movement disorders. The data reported by Paradiso et al. are an important step in that process and set the direction for promising future research.

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