Electrical activity in limb muscles after spinal cord stimulation is not specific for the corticospinal tract

TO THE EDITOR: We read with great interest the paper of Gandhi et al.2 (Gandhi R, Curtis CM, Cohen-Gadol AA: High-resolution direct microstimulation mapping of spinal cord motor pathways during resection of an intramedullary tumor. J Neurosurg Spine 22:205–210, February 2015). The authors try to demonstrate that electrical stimulation of the exposed spinal cord after tumor excision generates motor evoked potentials (MEPs) in upper- and lower-extremity muscles—presuming that this electrical stimulation exclusively activates fast-conducting axons of the corticospinal tract (CST) within the spinal cord. Unfortunately we are aware of a long history of similar but unsuccessful trials.

A method of translaminar stimulation of the spinal cord with recording of electrical activity from the peripheral nerves, so-called neurogenic MEPs,4 was introduced 2 decades ago. This method was subsequently disproven because strong evidence was found that the recorded activity is not generated by the CST.1,3 This was demonstrated by published data about 2 paraplegic patients with preserved “neurogenic MEPs.”1 Therefore, these recordings were never again called MEPs, and the method has been abandoned.

We now present evidence from a group of 13 patients with intramedullary spinal cord tumors (Seidel et al., unpublished data). In 7 of them, we recorded responses in muscles after stimulation of the dorsal column of the exposed spinal cord (Fig. 1A). On stimulation of the lateral column as judged by anatomical landmarks, responses in muscles were elicited as well (Fig. 1B). The elicited responses (in the muscles) after stimulation of the dorsal columns can be neurophysiologically explained by antidromic activation of the sensory fibers in the dorsal column that originated from spinal ganglion cells, which have collaterals to the alpha motor neurons.1 This is the so-called centrally activated H-reflex (Fig. 2).

Therefore we draw the conclusion that muscle responses to direct electrical stimulation of the exposed spinal cord are not specific for being transferred via the CST but can also be elicited by stimulation of the dorsal column alone. We conclude that the method of intraoperative stimulation of the exposed spinal cord cannot be recom-

---

FIG. 1. Stimulation of the dorsal and lateral column in a patient with a cervical intramedullary ependymoma at the C5–T1 level. The patient underwent a laminectomy via a dorsolateral approach, with recording of sensory and motor evoked potentials. Stimulation of the spinal cord was performed with a bipolar concentric probe applying a short train of 5 stimuli with a 0.5-msec pulse duration, an interstimulus interval of 4 msec, a 1.0-Hz repetition rate, and a stimulation intensity ranging from 0.5 to 2 mA. A: Intraoperative photograph showing the stimulation probe (Stim.probe) at the anatomical location of the dorsal column (left panel) and traces representing recordings from right tibialis anterior (TA) and right abductor hallucis (AH) muscles (right panel). B: Intraoperative photograph showing the stimulation probe laterally, representing the anatomical location of the lateral CST (left panel) and traces representing recordings from left TA and left AH muscles (right panel). Figure is available in color online only.
mended to anatomically identify the position of the CST within the spinal cord. This is especially important for the frequently distorted anatomy of the spinal cord in patients with intramedullary spinal cord tumors.

Vedran Deletis, MD, PhD
Albert Einstein College of Medicine, New York, NY

Karl F. Kothbauer, MD
Cantonal Hospital of Lucerne, Lucerne, Switzerland

Francesco Sala, MD
Institute of Neurosurgery, University Hospital, Verona, Italy

Kathleen Seidel, MD
Inselspital, Bern University Hospital, Bern, Switzerland

Response

We would like to thank Drs. Deletis, Kothbauer, Sala, and Seidel for their interest in our manuscript and for their elucidative comments regarding direct CST stimulation. In our manuscript, we described a case in which we used a Kartush concentric bipolar probe (Medtronic Xomed) to perform high-resolution microstimulation motor mapping of CSTs responsible for individual muscle groups during resection of a cervicomedullary junction cystic ependymoma. During stimulation mapping, we found that stimulation of a portion of the tumor margin led to the left lower-extremity electromyographic response. We limited tumor resection at that portion, and the patient suffered from a transient weakness in the left foot, further suggesting that the stimulation response was relevant. Due to the high morbidity associated with intramedullary tumor surgery, we hope that a proactive monitoring technique can potentially facilitate a more efficient and safer surgery. Dr. Deletis and colleagues have identified the unreliability of direct microstimulation of the spinal cord due to a suspected “centrally activated H-reflex.”

The authors discuss their experience in 13 cases of intramedullary spinal cord tumor. In 7 of those cases, they elicited motor responses by direct stimulation of the dorsal and lateral columns. We look forward to the authors’ final publication; the responses in the other 6 cases would be of value. One may hope for a detectable difference in response latency between direct stimulation of the CSTs and a collateral response after stimulation of the sensory tracts. Although the possibility of a centrally activated H-reflex would explain a false-positive stimulation, it does

References


Disclosures
The authors report no conflict of interest.