

NEUROPHYSIOLOGICAL MONITORING AND DORSAL COLUMN MAPPING IN INTRAMEDULLARY SPINAL CORD SURGERY

Clinical Overview

The Neurosciences Group at Roosevelt Hospital works closely with the prestigious group of neurophysiologists led by Vedren Deletis, MD, PhD. Dr. Deletis is one of the pioneers in the development of motor-evoked potential monitoring in spinal cord surgery. He gained extensive experience working with the late Dr. Fred Epstein on many hundreds of spinal cord tumor surgeries at NYU Medical Center, then at Beth-Israel North, and now at the Roosevelt Medical Center.

We collaborate closely with the neurophysiology team and have developed many techniques to monitor neural tracts to enable us to perform spinal surgery more precisely and safely. More recently, using dorsal column mapping to identify the physiological and functional midline of the spinal cord for myelotomy, this technique has enabled us to minimize injury to the dorsal columns. All patients undergoing intramedullary surgery have motor-evoked potential monitoring, somatosensory-evoked potential monitoring, dorsal column mapping, and the recording of “D” waves throughout the operation.¹⁻⁴

Intramedullary spinal cord surgery carries significant risk for neurologic impairment. Intramedullary spinal cord tumors are rare neoplasms accounting for approximately 2% to 4% of central nervous system tumors. These tumors are primarily astrocytomas and ependymomas. Astrocytomas commonly occur in the pediatric population, whereas ependymomas are more frequently encountered in the adult population. These tumors are very slow growing and can reach significant proportions within the spinal cord before becoming symptomatic. They tend to expand the spinal cord and can distort the surface anatomy.^{4,5}

Surgical resection is the definitive treatment for intramedullary spinal cord tumors.^{4,5,6,7} Resection of large centrally located intramedullary spinal cord tumors is achieved via a midline myelotomy. The midline in a normal cord is the dorsal median sulcus, located between the elevated posterior columns (Fig. 1.1). The midline can also be identified by following the dorsal median sulcal vein as it enters the midline raphe and also by locating a point midway between the root entry zones on either side.

However, this anatomy is frequently distorted in cases of tumor, due to edema, neovascularization, or scar formation. The distortion can be a combination of rotation of the cord and asymmetric enlargement, making identification of the surface anatomy extremely difficult (Fig. 1.1). Inadvertent dissection through the dorsal columns will cause postoperative sensory deficits, including the loss of proprioception, which can be disabling.^{2,5,6,7}

Dorsal column dysfunction is the most common cause of postoperative morbidity following myelotomy for spinal cord tumors, reported in 43.6% of patients in one series.⁷ Many authors believe that the dysfunction following intramedullary spinal cord surgery is, at least in large part, a result of injury to the posterior columns.^{5,7}

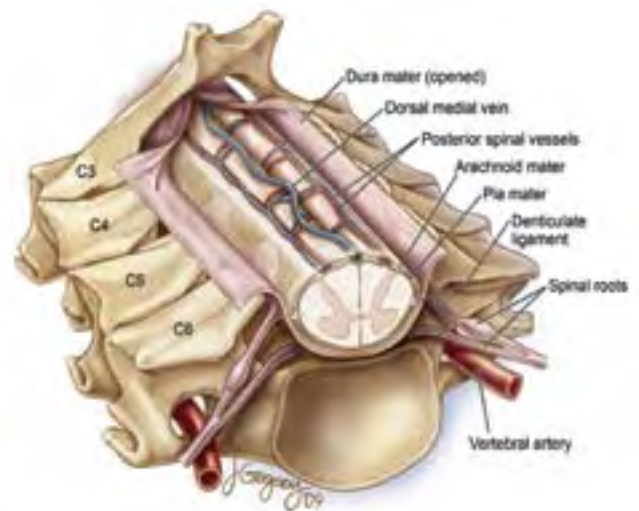


Figure 1.1. Artist rendering of normal spinal cord anatomy showing the elevated posterior columns and dorsal median sulcus



Figure 1.2 A miniature multi-electrode (1-8) grid is used intra-operatively to measure the amplitude gradient of conducted somatosensory-evoked potentials during functional mapping of the dorsal columns.

The standard microsurgical splitting of the dorsal columns from within the dorsal median sulcus is performed after identifying the midline via standard anatomical landmarks without any objective neurophysiological data. Injury to the dorsal columns during this dissection can result in dysfunction manifesting as numbness, tingling, painful dysesthesias, or ataxic gait.⁸

This can be significantly incapacitating on the patient's functional status and can affect the ability to rehabilitate. Decreasing the risk of dorsal column dysfunction remains a challenge in the treatment of intramedullary spinal cord lesions requiring a midline myelotomy.^{8,9,10}

Together with the standard pre-operative radiographic studies and intra-operative ultrasound to identify the exact location of the tumor within the spinal cord, we utilized an intra-operative functional technique of mapping the dorsal columns to help locate the midline for the myelotomy.^{6,8} This is accomplished by defining the amplitude gradient of conducted somatosensory-evoked potentials (SEPs) using a miniature multi-electrode grid (Fig. 1.2). These signals are interpreted intra-operatively by the neurophysiology team correlating the surgical anatomy with the functional anatomy. We have found this technique particularly useful in patients with large intramedullary spinal cord tumors and syringomyelia.^{9,10,11}