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Neurophysiological Monitoring's Effect on Intradural Spinal Tumor Surgery

Furkan Jung*

Department of Neurophysiology, Neurological Hospital P. Wertheimer, Hospices Civils de Lyon, 59 Boulevard Pinel, 69677 Bron, France

Introduction

Intradural spinal tumors are a rare and complex group of neoplasms that arise within the dura mater of the spinal cord. Their surgical removal poses significant challenges due to the critical and delicate nature of the spinal cord and the surrounding neural structures. Achieving a balance between maximal tumor resection and preservation of neurological function is paramount. Neurophysiological monitoring has emerged as a vital tool in this regard, offering real-time feedback on the functional integrity of neural pathways during surgery. This article explores the impact of NPM on the outcomes of intradural spinal tumor surgery, detailing its mechanisms, benefits, and future directions. Intradural spinal tumors can be broadly classified into two categories: intramedullary and extramedullary. Intramedullary tumors originate within the spinal cord itself, including astrocytomas and ependymomas. Extramedullary tumors, on the other hand, arise within the dura mater but outside the spinal cord, such as meningiomas and nerve sheath tumors. Symptoms of intradural spinal tumors vary based on their location and size but commonly include pain, motor weakness, sensory deficits, and autonomic dysfunction. Accurate diagnosis typically involves magnetic resonance imaging, which provides detailed anatomical visualization. Neurological complications, such as motor deficits, sensory loss, and autonomic dysfunction, are significant risks associated with intradural spinal tumor surgery. NPM helps mitigate these risks by providing continuous monitoring of neural function. Early detection of adverse changes allows for timely interventions, potentially preventing irreversible damage. The study found that intraoperative neurophysiological changes correlated with postoperative outcomes, emphasizing the importance of real-time monitoring in improving patient safety. The ultimate goal of intradural spinal tumor surgery is to achieve maximal tumor resection while preserving neurological function. NPM contributes to this goal by enabling the surgeon to perform more aggressive resections with confidence, knowing that they can monitor and protect critical neural pathways [1-3].

Description

NPM encompasses a range of techniques designed to assess the functional integrity of neural pathways during surgery. SSEPs measure the electrical responses of the brain and spinal cord to sensory stimulation of peripheral nerves. This technique monitors the dorsal columns of the spinal cord, which carry sensory information. MEPs evaluate the functional status of the corticospinal tract by stimulating the motor cortex and recording responses in the peripheral muscles. MEPs are crucial for monitoring motor pathways and preventing motor deficits. EMG records the electrical activity of muscles. In the context of spinal surgery, it is used to monitor the function of motor neurons and detect any inadvertent nerve root irritation or injury. tEMG involves direct electrical stimulation of nerve roots or the spinal cord to assess their functional status. It is particularly useful for identifying and preserving nerve roots during tumor resection. One of the primary benefits of NPM is its ability to enhance surgical precision. During intradural spinal tumor surgery, the surgeon must navigate through delicate neural structures to access and remove the tumor. NPM provides real-time feedback on the functional integrity of these structures, allowing the surgeon to make informed decisions and adjust their approach as needed. For instance, if a significant drop in MEPs is detected during tumor resection, it may indicate impending damage to the corticospinal tract. The surgeon can then pause or modify their technique to prevent permanent neurological deficits. Similarly, changes in SSEPs can signal potential injury to the sensory pathways, prompting immediate corrective actions [4,5].

Conclusion

Neurophysiological monitoring has revolutionized the field of intradural spinal tumor surgery, providing real-time feedback on the functional integrity of neural pathways and significantly improving surgical outcomes. By enhancing surgical precision, reducing neurological complications, and enabling more aggressive tumor resections, NPM plays a critical role in the management of these challenging tumors. As technology continues to advance, the integration of NPM with novel imaging techniques and the development of personalized monitoring protocols hold promise for further enhancing the safety and efficacy of intradural spinal tumor surgery. Ultimately, the continued evolution of NPM will contribute to improved quality of life for patients undergoing these complex and delicate procedures. Advancements in neurophysiological monitoring technology continue to expand the capabilities of NPM. New modalities, such as intraoperative diffusion tensor imaging (DTI) and functional MRI, offer potential for more detailed assessment of neural pathways and their functional status during surgery. Individualizing NPM protocols based on patient-specific factors, such as tumor location, size, and preoperative neurological status, can optimize the benefits of monitoring. Tailored protocols may improve the sensitivity and specificity of NPM, enhancing its overall effectiveness.

Acknowledgement

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Conflict of Interest

None.

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***Address for Correspondence:** Furkan Jung, Department of Neurophysiology, Neurological Hospital P. Wertheimer, Hospices Civils de Lyon, 59 Boulevard Pinel, 69677 Bron, France, E-mail: jungf@gmail.com*

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