

CASE REPORT

Intraoperative Magnesium Sulfate Infusion Enhances Neuroprotection and Muscle Relaxation during Brain Tumor Resection: A Case Report

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ABSTRACT

Intraoperative neurophysiological monitoring (IONM) is a valuable technique used during brain tumor resections to assess and preserve neurological function. This case report investigates the impact of intraoperative magnesium sulfate infusion on neuroprotection and muscle relaxation in the context of IONM during brain tumor resection. A 48-year-old male with altered awareness and occasional convulsive movements involving his right upper and lower limbs accompanied by progressive right-sided weakness and occasional sensory disturbances was diagnosed with a left temporal lobe tumor. He underwent craniotomy for tumor resection, with concurrent IONM and an intraoperative magnesium sulfate infusion. The patient's neurophysiological parameters, surgical outcomes, and postoperative recovery were analyzed, suggesting a potential synergistic effect between magnesium sulfate and IONM in optimizing patient outcomes.

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Introduction

Brain tumor surgeries are complex procedures, often involving delicate structures with high potential for neurological injury. The primary objective of these surgeries is to achieve maximal tumor resection, while minimizing damages to surrounding healthy brain tissue and preserving critical neural pathways (1). Intraoperative neurophysiological monitoring (IONM) has revolutionized the field of neurosurgery by providing real-time feedback on the integrity of the nervous system during brain tumor surgeries. This invaluable technique enables surgeons to detect and

respond promptly to potential neurological deficits, thereby improving patient's safety and outcomes. Intraoperative neuromonitoring, which includes monitoring of motor-evoked potentials (MEPs) and somatosensory-evoked potentials (SSEPs), allows surgeons to continuously assess the functional integrity of the corticospinal and somatosensory pathways, respectively (2).

Magnesium sulfate, a well-known neuroprotective agent, has shown promising effects in preserving nerve function and reducing the risk of neurological complications during surgical procedures. As an N-methyl-D-aspartate (NMDA) receptor antagonist,

magnesium can modulate calcium influx, reduce excitotoxicity, and protect neurons from injury during ischemic or traumatic events. Furthermore, magnesium's muscle relaxant effects can facilitate surgical exposure and minimize the risk of mechanical injuries during tumor resection (3). While both IONM and magnesium sulfate infusion have individually demonstrated benefits in brain tumor surgeries, their potential synergistic effect remains an area of interest. Combining these two approaches may lead to enhanced neuroprotection and surgical precision, ultimately improving patient outcomes and reducing the risk of postoperative neurological deficits (2, 3).

This case report aims to explore the clinical implications of utilizing intraoperative magnesium sulfate infusion in conjunction with IONM during brain tumor resection. By evaluating the impact on intraoperative neuromonitoring parameters, surgical outcomes and postoperative recovery, we searched to shed light on the potential benefits of this integrated approach in neurosurgical practice. Understanding the synergistic effects of magnesium sulfate and IONM may pave the way for optimized neuroprotective strategies and contribute to further advancements in brain tumor surgery.

Case Report

A 48-year-old male without any significant medical history presented with a one-month history of focal seizures that were manifested as altered awareness and occasional convulsive movements involving his right upper and lower limbs. Additionally, he reported progressive right-sided weakness and occasional sensory disturbances. His cognitive functions remained intact with no notable speech deficits. Magnetic resonance imaging (MRI) of the brain unveiled a well-defined contrast-enhancing lesion of approximately 4×3.5 cm in the left temporal lobe. The lesion displayed characteristic features suggestive of a low-grade glioma for further prompt evaluation and surgical consideration.

Preoperative assessment revealed mild right-sided hemiparesis, primarily affecting the upper limb, with muscle strength graded at 4/5 according to the Medical Research Council (MRC) scale. Sensory perception on the right side was mildly diminished, particularly in response to light touch and pinprick sensations. The patient's deep tendon reflexes were brisk on the right side, contrasting with the normal reflexes on the left side. Babinski sign was negative bilaterally, and no cerebellar deficits were noted. His higher cortical functions, including language and memory, appeared unimpaired upon comprehensive evaluation. Given the clinical presentation,

neuroimaging findings, and potential for progressive neurological decline, a multidisciplinary team of neurosurgeons, neurologists, and neuroradiologists recommended surgical intervention. The proposed approach involved craniotomy for tumor resection with concurrent IONM to safeguard critical neurological pathways and function.

Under general anesthesia, the patient was placed in the supine position with his head securely fixed in a three-pin skull clamp. A curvilinear incision was made along the left frontal temporal region, and a standard left temporal craniotomy was performed, exposing the tumor. IONM electrodes were strategically positioned to monitor MEPs and SSEPs throughout the procedure. To enhance neuroprotection and optimize surgical conditions, an intraoperative magnesium sulfate infusion was initiated prior to dural opening. The infusion regimen consisted of an initial bolus of 40 mg/kg of magnesium sulfate, administered intravenously over 20 minutes, followed by a continuous maintenance infusion at a rate of 10 mg/kg/h for the duration of the surgery.

The combination of intraoperative magnesium sulfate infusion and meticulous IONM allowed continuous monitoring and assessment of neural function during the tumor resection. The patient maintained stable MEPs and SSEPs throughout the surgical intervention, indicative of preserved motor and sensory pathways. Additionally, the surgical team noted a remarkable degree of muscle relaxation, facilitating precise and minimally invasive tumor resection. The tumor was successfully excised in its entirety, and a further intraoperative frozen section analysis confirmed the diagnosis of a low-grade glioma. Following the procedure, the patient was closely monitored in the intensive care unit (ICU) for the initial 24 hours. Neurological examinations conducted at regular intervals revealed no immediate deficits, and postoperative MRI confirmed the gross total resection of the tumor. The patient experienced a gradual resolution of his preoperative right-sided weakness, with muscle strength improving to 5/5 on the MRC scale within the first postoperative week. Sensory disturbances also showed significant improvement, and his overall clinical condition continued to ameliorate.

Discussion

The successful outcome of this case highlighted the potential synergistic effect of intraoperative magnesium sulfate infusion and IONM in brain tumor resections. The observed preservation of stable IONM signals, coupled with the profound muscle relaxation facilitated by magnesium

sulfate, contributed to the optimal surgical conditions and favorable patient outcomes. The primary objective of IONM was to evaluate the preservation of neural function and structures during neurological surgeries. This method was shown to be highly effective in preventing severe damages to the neural structures and promoting recovery after these surgical procedures (2). In this relation, magnesium sulfate can play an important role in protecting the nervous system. This compound has a significant role in reduction of the risks of intraventricular hemorrhage (IVH), the development of cerebral palsy (CP) in infants, and other neurological disorders, as well as being effective in anesthetic induction (3, 4). The recent findings suggest that magnesium sulfate may be a more effective alternative to lidocaine in various surgical procedures. It not only allows for a lower dosage of anesthesia, but also leads to a faster recovery time and improved pain profile after surgery. Additionally, it may decrease the need for muscle relaxants (5). Moreover, magnesium sulfate infusion led to lower postoperative opioid consumption, better pain scores and better sleep quality after surgery in multiple studies (6).

Conclusion

While further research is warranted to elucidate the precise mechanisms underlying this synergy, these findings underscore the importance of innovative approaches to enhance neuroprotection and refine surgical techniques in the realm of neuro-oncology. Continued exploration and refinement of such interventions hold promise for improved patient care and outcomes in the field of neurosurgery.

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Conflict of Interest

None declared.

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