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Case Report

D-wave monitoring enhance surgical decision making in intramedullary tumor surgery - Case report

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Abstract

Intramedullary spinal cord tumors present a formidable surgical challenge, requiring precise techniques to preserve motor function. Intraoperative neurophysiological monitoring (IONM) plays a crucial role in minimizing motor function damage, enabling surgeons to make informed decisions during surgery. Somato Sensory Evoked Potentials (SSEP), Electromyography (EMG), D-wave monitoring and Motor evoked potentials (MEP) provides real-time feedback on neurophysiological function, allowing for prompt adjustments to surgical technique.

We present a case report on the combined use of D-wave monitoring and MEP in predicting postoperative motor function in intramedullary tumor surgery. This report highlights the importance of multimodal IONM in optimizing surgical outcomes and minimizing motor function deficits. By integrating D-wave monitoring and MEP, surgeons can gain a more comprehensive understanding of motor tract function, enabling more precise and effective surgical interventions.

Keywords: IONM. D wave, MEP, Intramedullary spinal cord tumor

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1. Introduction

Intramedullary spinal cord tumors are a complex and challenging entity, necessitating meticulous surgical techniques to safeguard motor function and prevent debilitating neurological deficits. The delicate balance between achieving gross total resection and preserving motor function demands a high degree of precision and accuracy.[1] In this context, intraoperative neurophysiological monitoring (IONM) has emerged as a crucial adjunct to surgical technique, providing real-time insights into motor tract function and enabling surgeons to make informed decisions during the procedure. By continuously assessing the functional integrity of the motor tracts, IONM allows surgeons to adjust their technique in real-time, thereby minimizing the risk of iatrogenic injury and optimizing surgical outcomes.[2] Inraoperative monitoring of Motor Evoked Potentials (MEPs) and D-waves is crucial during the surgical resection of intramedullary tumors. These neurophysiological tests help assess the functional integrity of the motor pathways within the spinal cord. MEPs are used to monitor the motor function of the spinal cord, involving stimulation of the motor cortex and recording responses from the muscles. During surgery, MEPs help identify any changes in motor function, allowing the surgeon to adjust their technique and minimize damage to the spinal cord.[3]

D-waves are a type of MEP that specifically assesses the integrity of the corticospinal tract. They are recorded from the spinal cord and provide information about the functional state of the motor pathways. D-waves are particularly useful during the resection of intramedullary tumors, as they help the surgeon navigate the spinal cord and avoid damaging critical motor pathways. By using MEPs and D-waves, surgeons can identify the location of critical motor pathways within the spinal cord, monitor the functional integrity of the motor pathways during surgery, adjust their surgical technique to minimize damage to the spinal cord, and reduce the risk of postoperative motor deficits.[4]

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2. Case Presentation

A 35-year-old male presented with a two-month history of progressive bilateral upper limb weakness, followed by sudden onset weakness of bilateral lower limbs. The patient reported difficulty with daily activities, including walking, making food bolus, buttoning his shirt, and raising his hands over his shoulders. Physical examination revealed reduced power in bilateral upper limbs (2/5) and lower limbs (3/5), reduced tone in upper limbs, and reduced sensation in dermatomes C5, C7, and C8. Reflexes were brisk in lower limbs (3+) and reduced in upper limbs (1+), with up-going plantars.

Magnetic Resonance Imaging (MRI) of the spine revealed an ill-defined, predominantly eccentric, expansile solid-cystic lesion with surrounding edema, extending from the medulla to the lower endplate of the D4 vertebra (**Figure 1**). The lesion demonstrated heterogeneous signal characteristics, appearing hypointense on T1-weighted images and hyperintense on T2-weighted and STIR sequences, with patchy post-contrast enhancement. Additionally, mild disc bulges with annular tears were noted at the L5-S1 and L4-L5 levels, resulting in grade I central canal and bilateral lateral recess narrowing. These findings were consistent with a cervicodorsal intramedullary space-occupying lesion.

The patient underwent cervical laminectomy and subtotal decompression of the tumor under IONM guidance. Simultaneous Somato Sensory Evoked Potentials (SSEP), Electromyography (EMG), D-wave monitoring, and Motor Evoked Potentials (MEP) were performed during the surgery. D-wave monitoring was performed using an epidurally placed electrode positioned caudal to the surgical site, providing a direct indicator of corticospinal tract integrity and enabling accurate assessment of potential injury severity. Single pulse stimulation techniques for D waves allows for continuous monitoring without causing patient movement. The D wave is a direct asynaptic evoked potential, which make it relatively resistant to the effects of anesthesia[2]. Single pulse transcranial electrical stimulation was performed using corkscrew electrodes placed on the scalp according to the international electrode positions, C1/C2 or C3/C4. The stimulation parameters includes Pulse width 0.5ms, time base 10-20mS, Averages 1-20, high pass filter 100Hz and low pass filter 1000-3000Hz.[3]

The MEP stimulation was performed using transcranial electrical stimulation at C1/C2 and C3/C4 and MEP responses were recorded from multiple muscles in the upper and lower limbs.[4] The SSEP stimulation was performed bilaterally using electrical stimulation of bilateral Median and Tibial nerves. The SSEP responses were recorded from the scalp using surface electrodes placed at the following locations: C3'/C4' (contralateral to the stimulated nerve) for median nerve SSEP. Cz' (midline) and Pz' (midline) for Tibial nerve SSEP. (**Figure 2**a and b)

During the tumor resection, a sudden loss of MEP signals raised concerns about potential motor tract injury (**Figure 3**). However, simultaneous D-wave monitoring revealed a stable signal, indicating that the motor tracts remained intact. Guided by the reassuring D-wave signal, the surgical team continued with the tumor resection. The postoperative period was uneventful, with the patient exhibiting improved motor function and demonstrate significant enhancement in overall functional status suggests that the use of IONM was effective in preserving motor function. Histopathological examination of the resected tumor confirmed a diagnosis of ependymoma Grade 1.

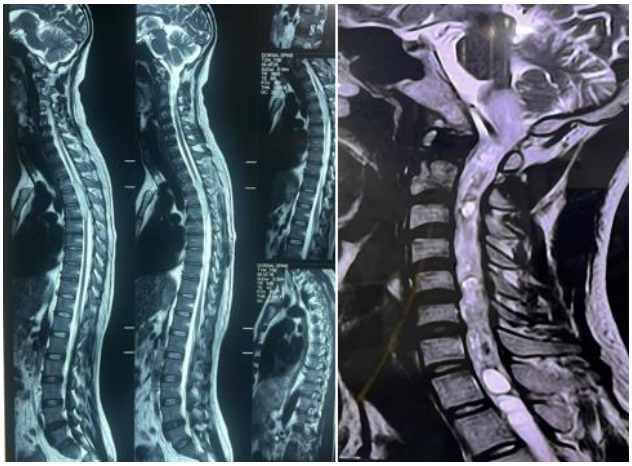

Figure 1: MRI shows cervicodorsal intramedullary space-occupying lesion

Figure 2: A: Base line normal MEP, SSEP, D wave and EMG responses; **B:** Normal consistent MEP and D wave responses

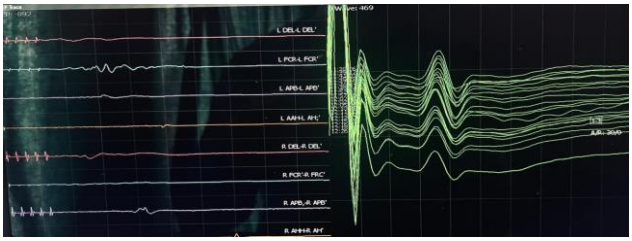

Figure 3: Markedly reduced MEP signals and normal stable D wav responses

3. Discussion

The transient loss of MEP signals during tumor resection can be attributed to various factors, including anesthetic effects, physiological or technical issues, which may lead to false positives.[5] In this scenario, the stable D-wave signal provided critical reassurance about the integrity of the motor tracts, enabling the surgical team to proceed with the tumor resection; leveraging the understanding that D-wave monitoring offers a more sensitive and specific indicator of motor tract function than MEP.[6] This case underscores the value of combining multiple IONM modalities, including D-wave monitoring and MEP, to inform surgical decision-making during intramedullary tumor surgery. By integrating these modalities, surgeons can minimize the risk of motor function deficits and optimize patient outcomes.

The use of D-wave monitoring in this case provided a more sensitive and specific indicator of motor tract function than MEP. D-wave monitoring is a direct indicator of corticospinal tract integrity, and its use has been shown to reduce the risk of motor deficits during spinal cord surgery.[7,8]

4. Conclusion

The case report highlights several important considerations for the use of IONM in spinal cord surgery. The use of multiple IONM modalities is essential to confirm the integrity of the motor tracts and D-wave monitoring provides a more sensitive and specific indicator of motor tract function than MEP.

5. Source of Funding

None.

6. Conflict of Interest

None.

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