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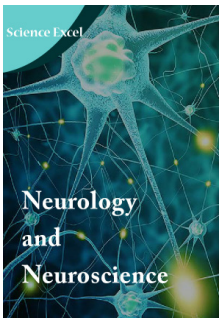

Prevention of Neurological Damage in Severe Cervical Stenosis: The Role of Intraoperative Monitoring and Proactive Measures

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Abstract

Cervical stenosis is a degenerative condition that causes compression of the spinal cord and nerve roots, resulting in neurological symptoms such as pain, weakness, and loss of motor and sensory function. Surgical treatment, such as spinal decompression, is indicated for severe cases, as untreated compression may lead to irreversible damage. Intraoperative neurophysiological monitoring (IONM) has proven essential for patient safety, allowing early detection of neurological changes and enabling immediate intervention. This article discusses the importance of IONM in severe cervical stenosis surgeries, highlighting preventive measures to minimize neurological damage. We report the case of a 57-year-old patient with severe cervical stenosis associated with myelopathy. A posterior surgical approach was chosen, with decompression and fusion, utilizing IONM to monitor motor potentials. Proactive measures, such as warm saline irrigation and maintenance of a mean arterial pressure (MAP) of 90 mmHg, were implemented to prevent neurological deterioration. After decompression, motor potentials returned to baseline levels, and the patient recovered without new neurological deficits. We conclude that IONM, combined with preventive strategies, is crucial in reducing the risk of neurological damage during severe cervical stenosis surgeries, ensuring greater patient safety.

Introduction

Cervical stenosis is a progressive degenerative condition of the spine that leads to compression of the spinal cord and nerve roots, causing neurological symptoms such as pain, weakness, and loss of motor and sensory function. This condition is commonly associated with degenerative cervical myelopathy (DCM), one of the most prevalent causes of spinal cord dysfunction in adults, especially in the elderly [1,2]. Surgical treatment, such as spinal decompression and cervical stabilization, is often indicated for severe cases of stenosis, as untreated spinal cord compression can result in irreversible neurological impairment [3,4].

Due to the complex anatomy of the cervical region and the risk of neurological injury during surgery, intraoperative neurophysiological monitoring (IONM) has been considered an essential tool for patient safety [5]. IONM allows for real-time detection of neurological changes during the procedure, enabling immediate interventions and preventing irreversible spinal cord and nerve root damage [6].

The importance of IONM is reflected not only in its ability to detect intraoperative neurological deterioration but also in its usefulness in guiding management during critical stages of the surgery, such as patient positioning and spinal decompression [7]. Furthermore, the implementation of preventive measures, such as maintaining mean arterial pressure (MAP) and using warm saline irrigation, are recommended strategies to optimize outcomes and reduce complications associated with the surgical procedure [8,9]. This article aims to discuss the relevance of IONM in cervical stenosis surgeries and highlight evidence-based proactive measures to minimize neurological damage.

Case report

A 57-year-old patient with a history of hypertension and diabetes presented with progressive left-sided hemiparesis and difficulty walking over the past six months. Clinical examination revealed pronounced weakness on the left side, hyperreflexia, and spasticity, with mild weakness in the upper limbs and moderate weakness in the lower limbs.

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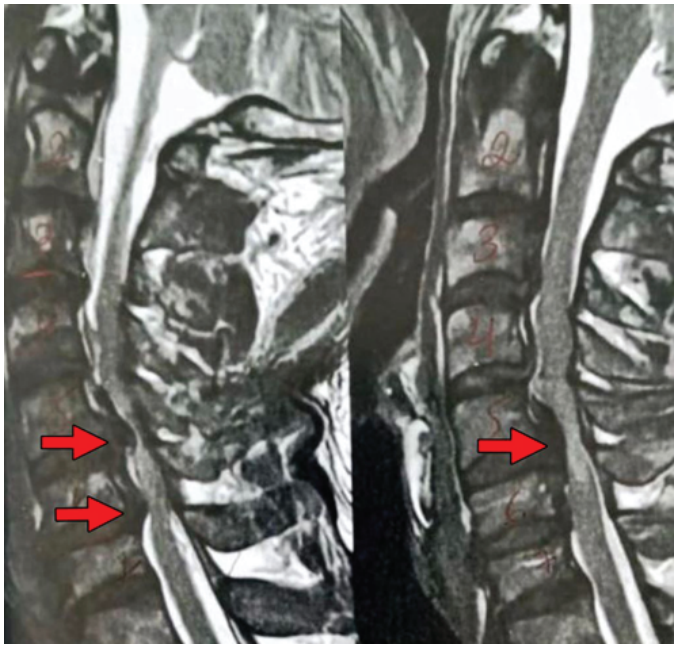

Figure 1. *T2-weighted sagittal MRI of the cervical spine showing severe cervical stenosis at the C4-C5-C6 levels, significant disc protrusions at these levels, with signs of spinal cord suffering/ myelomalacia.*

Cervical spine imaging revealed severe cervical stenosis due to anterior compression by a calcified herniated disc and ossification of the posterior longitudinal ligament at the C4-C5-C6 levels (Figure 1).

Given the multisegmental compression and preservation of cervical lordosis, a posterior approach was chosen. One of the key advantages of this approach is that it avoids manipulation of vital structures in the anterior neck, such as the trachea, esophagus, and large blood vessels, which would be at risk with an anterior approach. Additionally, the posterior approach provides better access for procedures like neural decompression and fixation with screws or rods, especially in cases of instability or deformities in the cervical spine. However, recovery can be slower, and the risk of complications, such as infections or injury to muscles and ligaments, is higher in older patients due to increased fragility of bone and soft tissues.

With the potential for worsening motor deficits during decompression, surgical treatment was planned with posterior decompression via laminectomy combined with fusion, with an emphasis on a proactive approach.

To anticipate possible deterioration and mitigate neurological damage, neurophysiological monitoring was implemented alongside preemptive measures, including continuous and vigorous saline irrigation and elevated mean arterial pressure (MAP) of 90 mmHg (the patient's baseline MAP was 65 mmHg, with no contraindications for cardiovascular issues). This strategy was specifically designed to stabilize spinal cord function before any neurophysiological deterioration could occur, based on prior experiences where such anticipation might have prevented unfavorable outcomes.

Laminectomy began at the C6 level and progressed upward to C4. Despite these preventive measures, motor potentials decreased during decompression, particularly on the left side, as expected given the severity of the compression.

The laminectomy took 15 minutes, and once completed, motor potentials returned to baseline levels after 10 minutes. The patient recovered without new neurological deficits, emphasizing the value of these proactive measures. Postoperative imaging demonstrated complete decompression with no spinal cord compression (Figure 2 and 3). After surgery, the patient was monitored in our ICU for 24 hours to ensure that the MAP remained above 90 mmHg, and was discharged on the third postoperative day.

Figure 2. *Postoperative CT scan of the cervical spine showing bone decompression at the C4-C5-C6 levels.*

Figure 3. *Postoperative T2-weighted MRI of the cervical spine showing decompression of the posterior complex at the C4-C5-C6 levels and release of the spinal cord, with remaining signs of prior myelomalacia.*

The use of intraoperative neurophysiological monitoring in cervical spine surgeries has been widely studied, with particular focus on degenerative cervical myelopathy (DCM). According to Wilson et al. (2023), IONM plays a crucial role in ensuring patient safety during cervical spine surgeries by enabling early detection of neurological damage before it becomes irreversible [10]. The ability of IONM to monitor motor-evoked potentials (MEPs) and other neurophysiological parameters in real-time helps surgeons immediately adjust their surgical techniques if significant changes in electrical signals, such as the loss of motor responses, are detected [11].

Furthermore, IONM has proven effective during critical stages of the surgery, such as patient positioning—a frequently overlooked yet essential phase to avoid spinal cord and peripheral nerve injury. Ali et al. (2022) highlighted that IONM can quickly detect neurophysiological changes during patient positioning, allowing for early correction of any spinal cord or nerve root compression that could be exacerbated during the procedure [12]. This early detection is particularly important in patients with severe cervical stenosis, where even small changes in position can result in significant neurological damage [13].

In addition to its role in intraoperative monitoring, IONM also contributes to real-time surgical decision-making. Fehlings et al. (2017), in their guidelines for managing degenerative cervical myelopathy, assert that IONM should be considered a standard practice during surgery, as it helps assess the severity of compression and guide the choice of the best procedure for each case [14]. The use of IONM not only allows for the detection of intraoperative complications but also provides real-time data that can influence critical decisions, such as the need for additional approaches or adjustments to the surgical plan to ensure patient safety [15].

At our institution, we have established a standardized protocol for patients undergoing surgery for DCM. This includes routine placement of an arterial line to maintain MAP above 85 mmHg throughout the procedure, considering each patient's cardiological status. Baseline neurophysiological potentials are obtained before patient positioning to establish a clear reference. After setting these baselines, patients are carefully positioned, and communication between the surgeon, anesthesiologist, and IONM team is maintained throughout the procedure to ensure optimal patient safety.

We also adopted a strategic approach to decompression, beginning with the less compressed levels and progressively moving toward the more compressed segments. This method minimizes the risk of neurological deterioration as decompression progresses.

Preventive measures, such as warm saline irrigation and maintaining adequate MAP, are widely recommended to optimize outcomes and minimize complications. Ali et al. (2022) discuss how warm saline irrigation helps maintain neurological function by preventing hypothermia and minimizing tissue damage during surgery [12]. Maintaining MAP above 85-90 mmHg is crucial to ensure adequate spinal cord perfusion, particularly in patients with significant spinal cord compression [14,16]. These preventive strategies are often combined with IONM to ensure that neurological function is preserved throughout the intervention [10].

In this specific case, we emphasized the importance of taking proactive measures before any significant loss or decline in motor potentials. Unlike previous experiences, where corrective actions were initiated only after evident neurological deterioration, we implemented preventive measures early (warm saline irrigation, MAP above 90 mmHg, normothermia, and confirmation of neuromuscular blockade reversal).

Therefore, integrating IONM into cervical spine surgical practices should not only be seen as a reactive measure but as a proactive approach aimed at ensuring patient safety and minimizing complications. The adoption of these strategies, combined with effective communication among the surgical team, anesthesiologists, and monitoring specialists, is crucial to the success of the intervention and the reduction of risks associated with cervical spine surgeries. In an increasingly evidence-based clinical context, IONM, alongside preventive measures, represents a key milestone in modern surgical practice [5,8].

Conclusion

IONM offers a significant advantage in the early detection of neurological deterioration, allowing for quick interventions that can prevent irreversible damage. Moreover, the implementation of preventive measures, such as warm saline irrigation and maintaining adequate MAP, complements monitoring and optimizes surgical outcomes, improving patient safety. Standardization of preventive measures and the integration of IONM should be considered an essential part of surgical management in complex cases of cervical stenosis.

Conflict of Interests

The authors have no conflict of interests to declare

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