Trends In Utilization Of Intraoperative Neuromonitoring During Anterior Cervical Spine Surgery

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Introduction

- **Intraoperative neurophysiological monitoring (IONM)** during spine surgeries assesses the nervous system through measuring **transcranial motor evoked potentials (Tc-MEPs)**, **somatosensory evoked potentials (SSEPs)**, and **electromyogram (EMG)** activity.

- While the debate on the efficacy and impact of IONM during spine surgery continues, **there is limited literature on how the use of IONM in routine anterior cervical spine surgeries has changed over time and the incidence of IONM alerts during these procedures.**
Purpose

- The purpose of this study is threefold:
  
  1. To examine the trends in utilization of IONM for anterior cervical surgeries
  
  2. To evaluate the corresponding incidence of IONM alerts
  
  3. To assess the utility of MEP monitoring in these cases.
Methods

- **Study Design:** This was a retrospective database review examining IONM data collected by Accurate Monitoring, LLC.

- **Patient Sample:** The study consisted of 9470 patients who underwent anterior cervical spine surgeries between Dec. 2009 and Sept. 2018.

- **Outcome Measures:** Tc-MEP, SSEP, and EMG alerts.

The IONM reports of patients who underwent anterior cervical spine procedures for various pathologies were analyzed. We considered cases in which at least one IONM modality (Tc-MEP, SSEP, EMG) was used, and we discarded cases in which the patient had a concurrent thoracic or lumbar spine procedure. An alert for the corresponding monitoring modality was recorded if it was indicated in the intraoperative report.
Results

- Out of the **9470 cases** examined, 6073 cases used **MEP (64.1%)**, 9451 cases used **SSEP (99.8%)**, and 7730 cases used **EMG (81.6%)**. All three modalities were used in 5755 cases (60.8%).

- In total, there were 266 MEP alerts (4.38%), 274 SSEP alerts (2.9%), and 710 EMG alerts (9.2%).
  - Table 1 shows a year-by-year breakdown of the utilization of the different IONM modalities.
  - Figure 1 shows an increase in the total number of anterior cervical cases using neuromonitoring over the past decade.
  - Table 2 shows that MMEP utilization is similar for ACDF procedures regardless of level.
  - Figure 2 shows that corpectomies exhibit the highest rates of MMEP alerts at 11.5%

- From the reports, it was not possible to determine if alerts were legitimate or due to artifact.

- The causes of the alert were opaque and seldom indicated; however, of note, in 107 cases with an alert, **anesthesia** was considered as a possible cause.
Table 1: The year-by-year utilization of IOMN modalities

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</thead>
<tbody>
<tr>
<td>Total Cases</td>
<td>211</td>
<td>494</td>
<td>677</td>
<td>783</td>
<td>1025</td>
<td>1299</td>
<td>1526</td>
<td>1858</td>
<td>1591</td>
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<tr>
<td>MMEP Used</td>
<td>173</td>
<td>252</td>
<td>409</td>
<td>536</td>
<td>714</td>
<td>884</td>
<td>1031</td>
<td>1099</td>
<td>969</td>
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<tr>
<td>%</td>
<td>82.0%</td>
<td>51.0%</td>
<td>60.4%</td>
<td>68.5%</td>
<td>69.7%</td>
<td>68.1%</td>
<td>67.6%</td>
<td>59.1%</td>
<td>60.9%</td>
</tr>
<tr>
<td>SSEP Used</td>
<td>210</td>
<td>494</td>
<td>675</td>
<td>782</td>
<td>1024</td>
<td>1298</td>
<td>1524</td>
<td>1858</td>
<td>1580</td>
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<tr>
<td>%</td>
<td>99.5%</td>
<td>100%</td>
<td>99.7%</td>
<td>99.9%</td>
<td>99.9%</td>
<td>99.9%</td>
<td>99.8%</td>
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<td>99.3%</td>
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<tr>
<td>EMG Used</td>
<td>189</td>
<td>362</td>
<td>558</td>
<td>638</td>
<td>791</td>
<td>1058</td>
<td>1307</td>
<td>1548</td>
<td>1273</td>
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<tr>
<td>%</td>
<td>89.6%</td>
<td>73.3%</td>
<td>82.4%</td>
<td>81.5%</td>
<td>77.2%</td>
<td>81.4%</td>
<td>85.6%</td>
<td>83.3%</td>
<td>80.0%</td>
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</table>

Table 1 shows a year-by-year breakdown of the utilization of the different IOMN modalities. SSEP was consistently the most utilized monitoring modality with MMEP being the least.
Figure 1 While there has been a linear increase in the overall number of anterior cervical cases that have utilized monitoring over the last 9 years ($r^2= 0.945$), there has been no apparent trend for the percentage of anterior cervical procedures that utilized MEP MMEP ($r^2= 0.0251$), SSEP ($r^2= 0.0044$), or EMG monitoring ($r^2= 0.0041$).
Table 2 shows a breakdown of MMEP utilization by procedure type. Routine ACDF only surgeries – regardless of number of levels – show a similar rate in utilization of MMEP monitoring at around 65%. Corpectomies show a proportionally higher rate of MMEP monitoring at 82%.
Figure 2 shows that corpectomies also exhibit the highest rates of MMEP alerts at 11.5%; ACDF surgeries involving more levels also showed a slightly lower rate of MMEP alerts.
Conclusion

• IONM in anterior cervical surgeries has been increasing over the past 10 years.
• While SSEPs are consistently the most commonly utilized modality, EMG and MMEP also provide additional information related to neurologic function.
• At present, IONM including a combination of SSEP, EMG and MMEP can provide the surgeon with information relating to the likelihood of postoperative neurologic injury during anterior cervical spine surgeries and may, in the future, prove to have a direct effect on clinical outcome.