COMMENTARY

Intra-Operative Monitoring with Somatosensory Evoked Potentials

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ABSTRACT

Intra-operative monitoring of somatosensory evoked potentials assesses the function of the dorsal columns in spinal cord surgery. We review its uses, interactions with anaesthetic agents and technical aspects of data interpretation.

Keywords: intra-operative monitoring, somatosensory evoked potential, spinal cord

INTRODUCTION

The risk of neurologic deficit resulting from spinal cord damage is 0.5 to 1.6% in cases of Harrington instrumentation for scoliosis but increases by up to 20% in cases of surgical decompression for spinal cord tumours or trauma.[1,2] The primary purpose of intra-operative monitoring (IOM) is to assess somatosensory pathway function in the hope of preventing and possibly reversing damage to nervous system structures during surgical manipulation of the spinal cord. Secondary purposes of monitoring are to provide the surgeon with information regarding possible improvement in neurological function following surgical intervention and to determine the efficacy of salvaging techniques. This article briefly considers the technical aspects and applications of somatosensory evoked potentials (SSEPs) in spinal cord surgery.

METHODOLOGY

Monitoring of SSEPs assesses the function of the dorsal columns but not of the motor system. Hence, preservation of SSEPs does not guarantee normal motor function. Although there is good correlation between preservation of SSEP and normal motor function, there are now reported cases of post-operative paraplegia with preserved SSEPs.[3,4]

Monitoring the motor tract may theoretically be a more logical alternative but this technique has its technical limitations. Clinical assessments, such as the ankle-clonus test and intra-operative wake up test, are still being used to provide physical confirmation of monitoring data. The wake up test has largely remained the gold standard for assessment of neurologic status during spinal surgery in some centres.

The selection of the nerve to be stimulated is determined by the segmental level of the surgical procedure. Spinal cord surgery above the eighth cervical segment can be monitored by SSEP from median or ulnar nerve stimulation, whereas spinal cord surgery below the eighth cervical segment requires monitoring SSEP from posterior tibial or common peroneal nerves stimulation.

In upper limb SSEP monitoring, stimulation of nerves at the wrist or elbow position are commonly employed. The placement of the stimulating electrode should be 1 to 2cm distal and posterior to the medial malleolus when monitoring posterior tibial SSEP. A ground plate electrode is placed between the stimulating and recording site.

Before the utilisation of muscle relaxants, stimulation should produce a minimal muscle twitch. For example, stimulation of the posterior tibial nerve should produce either a plantar flexion of the great toe or cupping of the sole of the foot. Alternating stimulation of the right and left posterior tibial nerve at a rate of 2 to 10/s is recommended.

Table 1. Anaesthetic agents and effects and SSEP responses.

Agents	Responses
Barbiturates Thiopental, Thiamylal, Surital, Methohexital, Amytal	No significant changes in latency or amplitude of early SSEP peaks. Mild attenuation of peaks, latency delays and morphology alterations.
Halogenated Inhalation Agents Halothane, Enflurane, Isoflurane, Nitrous Oxide	20% decrease in amplitude
Halogenated Inhalation Agents- Narcotics Morphine, Demerol, Dilaudid, Fentanyl, Sufentanil, Alfentanil	Minimal increase in latency
Non-Barbiturate induction Agents Etomidate, Propofol, Ketamine	Increase latency 8%, amplitudes not affected.
Benzodiazepines Diazepam(Valium), Lorazepam(Ativan), Clonazepam(Klonopin), Nitrazepam, Midazolam	No changes
Hyantoins Phenytoin, Diphenyhydantoin	No changes
Neuromuscular Blocking Agents Pancuronium(Pavulon), Succinylcholine(Anectine), Vecuronium	Decreases muscle artifact resulting in cleaner tracing

The electrode sites (CPZ and FPZ) are marked according to the 10-20 system and fixed with collodion for tibial recording. For median recording, C3 and C4 recording positions are employed. Alternatively, recordings can be obtained with needle scalp electrodes.

INTERACTIONS

Anaesthesia

Many of the intra-operative changes in SSEP signals that are observed are due to anaesthetic drugs. These changes can resemble those caused by surgically-induced neurologic dysfunction, including a decrease in amplitude, increase in latency, increase variability and absence of the cortical response. Most of the inhalation agents significantly prolong the latency and decrease the amplitude. If there is a large fluctuation in the anaesthetic regimen, it may be difficult to distinguish the resultant changes in the SSEP data from those that could be caused by damage to the nervous system. This is particularly problematic if a major alteration in the anesthetic regimen is made at the same time as when a critical surgical manoeuvre, such as spinal distraction, is being performed. Continuing dialogue between the technologist and anaesthesiologists is vital to preventing such occurrences. With the use of narcotics agents such as propofol and etomidate, the latency of the cortical response remains unchanged or is only slightly prolonged with amplitudes actually increasing.[5] Table 1 summarises the effects of various groups of anaesthetic agents on SSEP recording.

Blood Pressure

The patient's blood pressure itself can affect SSEP signals independent of the effects of the anaesthetic agents. A decrease in blood pressure may cause cerebral ischaemia and mild amplitude attenuation. It is important to keep blood pressure stable because fluctuating blood pressure may result in fluctuating cortical amplitude, causing interpretation dilemma. Blood pressure should be included in the IOM data logs. Notification of the surgical team and intervention to increase the blood pressure can lead to recovery of the SSEP signals.

Temperature

Core temperature and limb temperature should be monitored during the course of surgery, as temperature will result in decreased conduction velocity and gradual prolongation in peak latencies of the cortical signal. Response amplitude is generally not affected. Cortical SSEP is difficult to record at temperatures below 32°C. Figure 1 illustrates an actual example we monitored.

DATA INTERPRETATION

Amplitude and latency of the cortical responses at 37 ms and 45 ms are established before surgery and at the beginning of the procedure. Changes in amplitude and latency must be correlated with temperature, blood

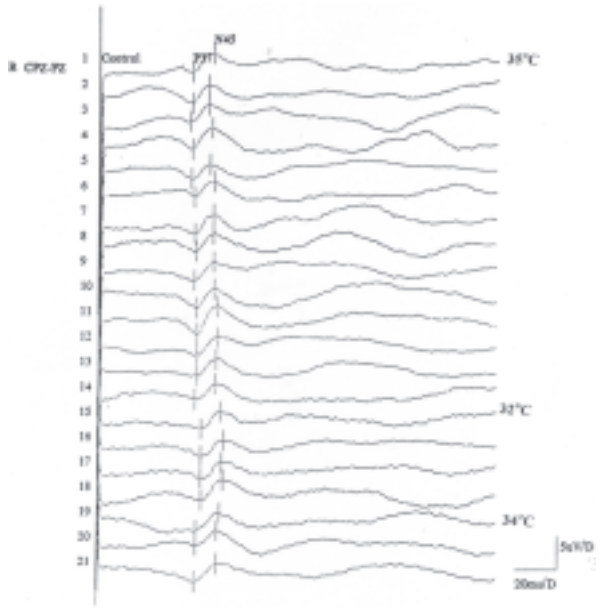

Fig.1. Effects of nasal prong body temperature on posterior tibial SSEP. This figure illustrates gradual prolongation of P37 latency with decreasing body temperature and reduction with increasing body temperature. Note that the amplitude was not significantly altered. Each trace was obtained at two minute intervals approximately.

pressure, pharmacologic factors (intravenous drugs, anaesthetic agents), and surgical factors (traction or rotation of spinal cord, vascular compromise of spinal cord). Table 2 shows the recommended standard for interpretation of changes during IOM SSEP monitoring. Alteration in SSEP parameters are reported immediately to the surgical team.

If there is a prolonged disappearance of the cortical signals, the patient has a significant chance of neurologic impairment post-operatively. Nuwer has suggested that a greater than 50% amplitude attenuation of cortical signals is probably correlated with a 25% chance of post-operative impairment, whereas less than 50% attenuation is probably not associated with a significant risk of a deficit.[6]

Table 2. Recommended standards for interpretation of changes during intraoperative SSEP monitoring.

Decrease in baseline amplitude of 30%–50%	Monitor closely
Increase in baseline latency < 2 msec	Monitor closely
Decrease in baseline amplitude of >50%	Alert surgeon
Increase in baseline latency > 2mses	Alert surgeon

CONCLUSION

Intra-operative SSEP of the spinal cord is a fairly recent neurophysiological technique. At this time, however, significant limitations restrict the utility of monitoring. Recent advances, particularly the development of methods for evaluation of motor tract function coupled with improved recording technology, should enhance and extend the role of SSEP monitoring in limiting the morbidity of spinal cord surgery.

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