Somatosensory Evoked Potentials of the Cervical Spine and Upper Extremities, Part II

By David BenEliyahu

Somatosensory Evoked Potentials (SSEP) are a useful electrodiagnostic method of differentiating central nervous system disorders (i.e., MS) from spinal root disorders, polyneuropathy, and peripheral nerve entrapments.\(^1\)\(^-\)\(^10\) SSEP can be especially helpful when used with dermatomal studies (DSSEP), in the evaluation of double crush syndrome.

Chiappa has stated that SSEPs are one of the most accurate methods of assessing axonal continuity. SSEP/DSSEP may be performed in the upper extremity area by either stimulating a peripheral nerve (i.e., radial, ulnar, median, musculocutaneous) or a specific dermatome (i.e., thumb-C6, middle finger-C7, fifth digit-C8). DSSEPs increase the sensitivity of conventional SEP testing for cervical spine dysfunction. Stimulating only the median nerve could lead to error, and false negatives, because it is a mixed nerve comprised of many levels (C5-T1), and a single level lesion could be compensated by axonal continuity of the other intact fibers of the median nerve.

SEP testing entails applying surface electrodes along various regions of the body to monitor and record ascending electrical volleys from distal points of stimulation (Fig. 1).

Signal averaging is the process of collecting data when stimulating the peripheral nerve or dermatome hundreds of times, to filter out extraneous electrical noise and only allow analysis of reliable and accurate waveforms.

Data collection is carried out through a series of surface electrodes in a commonly used three channel montage. The first channel is typically placed at the ipsilateral Erbs point; the second channel at the cervical spines SP, at either C2, C5, or C7; the third channel is placed at the contralateral side of the skull, C3 or C4 (Fig. 1).

The electrical waveforms observed at these channels are typically labeled according to the time in milliseconds it normally takes to reach or pass that region. N9 for the peak observed at Erbs point, N13 for the peak seen at the cervical spine, and N20/P25 for the peaks seen at the contralateral cortex. While the three channel montage is most commonly used, some labs as well as the American Electroencephalographic
Society recommends a four-channel pick-up montage.\(^\text{11}\)

Normal values for amplitude and latencies have been established by various authors and researchers.\(^\text{12-20}\) Synek has published normal DSSEP values for dermatomes C6, C7, C8.\(^\text{14}\) Slimp et al., published normal values for the cortical peaks of the C4-C8 dermatomes.\(^\text{13}\) Pop et al., also published normal values on obtaining cortical peaks of the C5-C8 dermatomes including right to left differences.\(^\text{12}\) They found that unlike lower extremity SSEP studies, upper extremity studies are independent of height or body length. Delisa, Eisen, Chiappa and other have published normal latency values, amplitude values, and interpeak latency values (Fig. 2).

SSEP testing has been widely published in scientific literature as a reliable method of electrodiagnosis for disorders such as cervical disc prolapse; thoracic outlet syndrome; brachial plexopathy; cervical radiculopathy and myelopathy; spinal stenosis and peripheral nerve entrapments.\(^\text{2-20}\) The advantage of SSEPs is in the numerous surface electrode monitors that are used to record normal, delayed or absent electrical wave forms from distal stimulation of a peripheral nerve or dermitome.

Criteria for abnormality:

- absent peaks or wave forms

- delayed interpeak latencies (the time measure between two peaks, i.e., N9-N13).

- slowed peripheral conduction velocity

- r/l latency asymmetries greater than 2.5-3.0 standard deviations of normal values

- abnormal amplitude ratios, amplitude morphologies, and right to left asymmetry (note: amplitudes are secondary criteria for abnormalities, and some experts do not use amplitudes for abnormality)
Distal stimulation can be performed serially to help isolate the point of nerve entrapment. For example, if ulnar nerve stimulation at the wrist is abnormal, below the elbow is abnormal but above the elbow is normal, ulnar entrapment at the elbow is a likely diagnosis. SEP testing has been shown to be useful in the diagnosis of thoracic outlet syndrome by several authors who commonly found N9 and N13 changes are ulnar nerve stimulation. Interpeak latencies (N9/N13, N13/N20, N9/N20) may be prolonged as well.\textsuperscript{6,7,8} Using amplitude ratios, and N9/N13 interpeak latencies, Machleder found a 74 percent sensitivity with SSEPs. SSEPs have been shown to be useful in cervical disc disease with Leblhuber finding an 85 percent sensitivity; Schimsheimer finding an 81 percent sensitivity in conjunction with the flexor carpi radialis H reflex. Heisarki also found that SSEPs were valuable in a diagnosis of radiculopathy and myelopathy as an outcome measuring tool for surgical management.\textsuperscript{3,4,5} Urasaki published a study that found that intraoperative epidural recording of median nerve stimulation at N13 was associated with the C6 spinal segment.\textsuperscript{10} Synek, Jones, Chiappa and others have shown SSEPs useful in the evaluation of brachial plexus lesions and injuries.\textsuperscript{8,9,10,11}

I have found SSEP/DSSEPs especially useful in a diagnosis and management of double crush syndrome since it can help isolate several areas of focal impingement in the same neuroaxis or peripheral nerve. To successfully manage double crush syndrome, all areas of entrapment must be addressed, otherwise suboptimal treatment will result. Our lab has seen a close correlation between SSEP/DSSEP abnormalities and MRI identified levels of disc protrusion. In addition we have found good utility for SSEP with thoracic outlet syndrome using a neutral and dynamic positioning protocol. In my sports practice, SSEP/DSSEPs have been helpful in diagnosing peripheral nerve entrapments, and plexus injuries.

SSEPs are reliable outcome measure tools to follow a patient’s response to care and/or need for different modalities of care if unresponsive.\textsuperscript{21-23} Capria et al., found abnormal SSEPs revert to normal after chiropractic treatment, and other authors have shown its utility as an introperative tool and postsurgical assessment tool. In a case report I recently published in the JMPT on chiropractic care for the cervical disc herniation, we showed that not only did the MRI findings resolve but so did the SSEP abnormalities post-chiropractic care. In a large research study currently underway we are using MRI pre and post-chiropractic care to document the percentage of resorption and resolution of the disc herniations seen. In a subset of the study, the electrodiagnostic method of SSEP/DSSEPs will also be used pre and post chiropractic care. Anyone interested in participating in this study who has vast experience in the care and management of disc cases, and with MRI, should contact me at (516) 736-4414.
Somatosensory and dermatomal somatosensory evoked potentials are sensitive, specific, and reliable methods of electrodiagnosis germane to clinical chiropractic practice.

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References available on request

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