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The Differential Diagnostic Somatosensory Evoked Potential: a Critical Appraisal of a New Electrodiagnostic Technique

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A new diagnostic technique may be sweeping across the country. This new technique is called the differential diagnostic somatosensory evoked potential (DDSSEP). Since it utilizes somatosensory evoked potential technology, the DDSSEP is being marketed as an improvement of a medically accepted and scientifically validated diagnostic procedure. But are these and other claims made of the DDSSEP technique based on fact or fiction? Before you buy into this technique, you may want to read this review.

Last summer I completed a literature review on somatosensory evoked potentials (SEP) and dermatomal somatosensory evoked potentials (DSEP) as an invited author and chapter contributor in the recently released series, *Advances in Chiropractic* by Mosby publishers.¹ In reviewing the literature regarding the use of SEPS and DSEPs for the detection of radiculopathies, it became clear that these evoked potentials were not quite as sensitive in the detection of radiculopathies as had been initially thought or hoped for. The same or similar conclusions have also been reached by authoritative members of the electrodiagnostic research community.^{2,3} While the DDSSEP is based upon the same technology and methodology as SEPs and DSEPs, the DDSSEP differs significantly from these other tests in that it is used to diagnose conditions for which SEP were never intended, and it utilizes standards which have never been published, much less studied. The following is an excerpt on DDSSEP from that chapter¹ with permission from Mosby.

"As with any stated rule, an exception may be found provided one searches exhaustively. Having reviewed the authoritative and investigative literature regarding SEPs and DSEPs, and finding no disagreements about their lack of utility as a stand alone test, one dissident opinion is provided by Glick and Lee⁴ in the differential diagnostic somatosensory evoked potential (DDSSEP) technique. The DDSSEP technique is claimed to provide a greater degree of sensitivity, specificity and accuracy than standard SEPs and DSEPs.⁴ It differs significantly from standard SEPs and DSEPs in that its purported improved diagnostic yield is

based upon theory⁴ rather than acceptable scientific standards. It also differs methodologically from traditional SEPs and DSEPs in that invariable stimulating and recording procedures are adopted (five stimulated sites bilaterally) for either the upper or lower extremities, regardless of the clinical problem. Furthermore, absolute and relative differences in latencies, interpeak latencies and amplitudes are employed in the determination of abnormality; however, the exact criteria used to define abnormality, as well as the standards upon which these are based have yet to be published, at least in the public domain. Needless to say, it doesn't take a clinical epidemiologist to realize that this many multiple tests with multiple criteria for abnormality would result in very few normal individuals being classified as normal after testing. A conservative estimate based on 10 stimulation sites and 3 recording sites for absolute and relative differences in latencies, interpeak latencies and amplitude at a 3 SD cutpoint is given by 0.99180 or only 16 chances in 100 of being classified as normal after the DDSSEP test.

"One of the scant research which has been conducted on the DDSSEP technique^{5,6} all have been associated with the same investigative team and are available only as abstracts of proceedings where critical appraisal becomes difficult due to limited information. None of these studies have addressed the critical clinical issues and none have employed adequate scientific control over those questions which have been addressed. Two examples are worthy of elaboration of this point. The DDSSEP has been theorized to be capable of detecting carpal tunnel syndrome (CTS).⁴ In a study⁷ 26 patients with unspecified CTS symptomatology were evaluated by DDSSEPs and not one of the patients were diagnosed as having CTS by this technique. Since a gold standard test for CTS detection was not utilized there is no way to be certain that these patients had CTS. Two possible explanations emerge. Either these patients had CTS and DDSSEPs were insensitive to its presence (which is entirely possible when a long nerve segment is used to detect a focal lesion), or all of these patients were incorrectly diagnosed on clinical grounds. In either case, this study only serves to compare one unknown against another. These authors further state that while DDSSEPs did not identify CTS, none of the patients were normal either, and the test results were compatible with cervical radiculopathy, brachial plexopathy or cervical myelopathy. Although authors suggest this is evidence that CTS is caused by more proximal 'neurologic insult,' it may equally be taken as evidence that the DDSSEP technique yields extraordinary high false positive test results. The second example involves the reliability of measurements made in the DDSSEP technique. In a study on the reliability of upper extremity latencies used in all SEP techniques, analysis was performed by multivariate analysis of variance and reliability reported by intraclass correlation coefficients that range from 0.66 to 0.94.⁸ Although SEP latency measurements have long been blindly accepted as reliable, this study significantly contributes to the field by

verifying with appropriate statistical methods the suspicions of those in the field. However, minor variation in amplitude of evoke responses have long been considered too inaccurate for clinical diagnosis. The DDSSEP technique departs from traditional SEPs in this regard and relies heavily upon minor amplitude variations as a diagnostic parameter. In a reliability study of minor amplitude variations by this same group⁹ there is a conspicuous omission of statistical details necessary to the appraisal and interpretation of the study, whereas in the previous study on latencies these details were provided. Perhaps this was nothing more than an attempt to avoid redundancy by the authors, in which case they have additionally avoided providing substantive evidence that minor amplitude changes be reliably measured.

"In summary, the DDSSEP technique builds upon the scientific foundation of DSEPs (which is of uncertain diagnostic value itself). It additionally extends beyond DSEPs by purporting to detect neurological deficits for which DSEPs have never been evaluated, utilizing amplitude changes to a greater degree than can be prudently supported, is ill supported by either diversity of investigative teams or adequate research design. DDSSEPs also exceed all reasonable expectation for any clinical neurophysical test in claiming to be adequate as an isolated neurophysiological diagnostic test. Because DDSSEPs represent a significant methodological departure from DSEPs, much of the literature regarding DSEPs cannot be directly applied to DDSSEPs. The DDSSEP technique will be required to stand on its own merits, based upon substantive and acceptable investigative studies. Based upon the scant literature currently available on DDSSEPs, the test procedure is premature for any clinical applications. Not even the most basic information is available on this technique, such as the normative data base and cutpoints for normality. There are several flaws in conventional neurophysiological wisdom, such as utilizing long nerve segments to detect focal neuropathies as in carpal tunnel syndrome, which suggest unsound theoretical constructs upon which DDSSEPs are based. Furthermore, the routine use of a multitude of criteria by which to judge abnormality defies epidemiological wisdom as well and is predicted to result in an inordinately high false positive detection rate. Regardless of whether any paraclinical test is based upon sound or faulty theory, it cannot be offered as a clinical test until it has been reproducibly validated."

Following the completion of this segment for *Advances in Chiropractic*, another abstract by Glick became available.¹⁰ This abstract appears equivocal to compare the results obtained from lower extremity DDSSEP studies to those of MRI, but no statistical comparisons are ever presented. The only results presented are that all DDSSEP studies and MRI studies were abnormal to some degree. No statistical comparisons are provided by level or side of involvement. Furthermore, the selection criteria used for case inclusion are

never discussed. If all cases were required to have a positive study by both tests, then the results that were indeed positive become meaningless. The result of particular interest was that 23 of the 30 cases studied showed DDSSEP abnormalities of the common peroneal nerve in those cases in which the MRI revealed one or multiple disc bulges or herniations with limited or no encroachment into the IVF. The author implies that this is evidence that the posterior division of the sacral plexus was involved in addition to a specific nerve root. It should be obvious that it is anatomically impossible for a lumbar disc bulge (or even a herniation) to affect the sacral plexus. Since the sensory contribution to the common peroneal nerve is comprised of representation from the L4, 5 and S1 roots, such a multisegmental nerve cannot logically demonstrate abnormalities (thereby resulting in false positive test results). The results of Glick's study are similar to those reported by Feinsold et al.,¹¹ in which 100 percent of 76 cases showed abnormalities in peroneal SEPs for L4, L5 or S1 radiculopathies. In Feinsold et al., this erroneous finding has been attributed to rather liberal criteria of abnormality.³ In the study by Glick,¹⁰ although the specific criteria by which peroneal DDSSEP abnormality are not discussed, similarly liberal criteria would explain the similarity of results between these two reports. In essence, Glick's most recent abstract has done little to scientifically validate the DDSSEP technique. On the contrary, it has only served to heighten the previous suspicions that too liberal a criteria by which to judge abnormality are employed in the DDSSEP, invariably leading to false positive test results in the majority of patients tested.

It may be said that normality can be defined as an absence of sufficient diagnostic testing. Even when a diagnostic test with conservative criteria for abnormality is applied, a certain proportion of normal individuals will yield a test result within the abnormal range. When liberal and/or multiple criteria are adopted for abnormality, normality may become a rare condition, even within the normal population. Such an explanation best describes the results obtained from studies regarding the DDSSEP technique. Without publication of the criteria for DDSSEP abnormalities, the suspicion for liberal criteria cannot be denied or supported. However, neither science nor clinical laboratory studies can be supported or justified by unpublished proprietary standards. All too often, chiropractors are enticed into purchasing clinically premature diagnostic innovations, only to later place blame on the chiropractic scientific community for objectively exposing the prematurity and lack of scientific validity of these innovations once in full swing. I hope in the case of DDSSEP, forewarned is forearmed. If the DDSSEP is eventually shown to be scientifically valid as a useful paraclinical diagnostic study, then there is no rush to become involved in the DDSSEP as it will be around for a long time. If on the other hand it turns out to be another instrumentation fad, you will have spared yourself a sizable investment in a trinket for your storage room.

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