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CORRELATION BETWEEN CORTICAL SOMATOSENSORY EVOKED POTENTIALS AND MRI IN PATIENTS WITH LUMBOSACRAL RADICULOPATHY

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- **ABSTRACT**

Background: MRI and somatosensory evoked potentials (SEP) have been used in evaluation of different aspects of radiculopathies. Investigators have been interested in comparative values of these tests.
Objective: To determine the clinical value of truncular and dermatomal SEP in diagnosis, localization and prognosis of lumbosacral radiculopathy and its sensitivity relative to MRI.
Methods: The lower extremity SEP studies were done in 34 patients with definite clinical and MRI findings of lumbosacral radiculopathy. The findings were compared with those obtained from the control group which consisted of 35 healthy individuals.
Results: Among 33 patients with abnormal MRI,29 had abnormal SEPs (87.8%). The concordance of SEP with MRI regarding the level and side of affected roots was 65.5%.
Conclusion: MRI overestimates disc bulge in some patients. As a low-cost and sensitive tool, SEP is recommended to be used in addition to MRI in evaluation of lumbosacral radiculopathy

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Key Words • Somatosensory evoked potentials ? electrodiagnosis ? spinal stenosis ? sensitivity

Introduction

Low back pain (LBP) is the most common cause of pain ranking in frequency only second to headache.[1,2] Although lumbosacral radiculopathy is an infrequent cause of LBP it often results in persistent disability necessitating extensive medical evaluation and treatment.[3]

Increasing availability of non-invasive and sensitive imaging procedures have heightened awareness of the high frequency of spinal degenerative changes and intervertebral disc disorders in the asymptomatic population. MRI studies have demonstrated lumbar disc protrusion and herniation in 18% to 20% of asymptomatic individuals in all age groups and 36% of asymptomatic subjects over the age of sixty.[4,5]

Electrodiagnostic tests are valuable adjunct procedures capable of distinguishing lumbosacral root injury from pain due to musculoskeletal causes.[6]

Evoked potentials are the electrical responses of the nervous system to motor or sensory stimulation. Most somatosensory evoked potentials (SEPs) are produced by electrical shocks applied to the nerves of the arm and leg. Lower extremity SEPs are elicited by stimulation of lower limb nerve trunks and recorded over lumbar, lower thoracic and scalp reflecting activity of the cauda equina, lower spinal cord and somatosensory cortex, respectively.[7-10] In the assessment of lumbosacral radiculopathies SEP has been used with conflicting results.[11 17] Some studies have found abnormalities in 92-97% of patients[15,17,18] while others[11,12] describe abnormalities in around 26% of the patients. In southern Iran low back pain, lumbosacral radiculopathy and spinal stenosis are frequently encountered in the clinics mostly because of sub-optimal working standard on rice farms, factories[19] , and more recently also due

to the growing number of elderly population. SEP as a non-invasive and inexpensive procedure can be very helpful in the management of these patients in the developing countries.

Materials and Methods

All examinations were done in an air- conditioned quiet room with the same evoked potential machine (Toennies multiliner version 2.0, Electromyography, Germany). A filter setting of 10Hz-2KHz, a stimulation frequency of 3Hz and an impulse duration of 0.2ms were utilized

Recording electrodes were 9mm disk electrodes placed at Cz? , and referenced to Fz in accordance with international 10-20 system. The resistance was reduced to <2 kohms.

Stimulation technique:

Evoked potentials (EP) were obtained according to the usual protocols of standard texts of EP, by the use of surface and ring electrodes. The tibial nerve behind the medial malleolus, common peroneal nerve (CPN) at the knee level and L_4 L_5 S_1 dermatomes were stimulated above the tip of the medial malleolus and at base of the big toe, and the base of the little toe, respectively.

At least 2 sets of averages (200 sweeps each) were made. Amplitudes were recorded between the first positive peak, and the next negative peak, and latencies were measured from stimulus artifact to the response positive peaks.

Experimental studies

Population: We studied 34 patients (18 women and 16 men), ranging in age from 28 to 70 years(mean age 43.5 years), harboring clinically unequivocal lumbosacral radiculopathy.

In one case SEP findings were completely inconsistent with MRI. This case had normal MRI but abnormal SEP of CPN which was more consistent with his neurological findings.

Low back pain had been present for one month to eight years, with a mean of 26 months. All patients complained of sharp, radicular type pain radiating into one or both legs and 27 patients had focal reflex or sensorimotor changes. Twenty-two of 33 patients had a positive straight-leg-raising sign. All patients had at least one of above clinical features while they had no history or clinical signs of diffuse peripheral nerve or spinal cord disease.

All patients underwent an MRI study of lumbosacral region. Axial views utilizing spin-echo T_1 weighted and sagittal views with T_2 weighted images were obtained. As a rule, radiographic information was not known at the time of the electrophysiologic examination.

SEP examination:

For all patients dermatomal somatosensory evoked potentials (DSEP) (L_4-L_5-S_1) and truncular SEP (CPN and tibial) of both legs were conducted with the same electromyograph as in the normal group and the same standards for patient installation were regarded. We measured the amplitude and latency of the initial positive peak. Values were compared with those obtained in 35 normal subjects. DSEPs were considered abnormal if there was a side-to-side difference of more than 2 SD from the normal mean for the particular segmental level, or an absolute latency that departed from the height-latency regression

line by more than 3 standard errors.[8,13] DSEPs were also regarded as abnormal if the response was absent on one side or less than 25% of the amplitude of the other side. Results of imaging studies were then compared with electrodiagnostic and clinical findings.

Results

Among the 33 patients with abnormal MRI, 29 (87.8%) had abnormal SEP. DSEP abnormality only, was found in 9 (31%) and exclusive truncular SEP in 2 (6.8%) cases In 18 (62%) both types of SEP were abnormal. All of the six patients who had MRI findings consistent with spinal stenosis had also abnormal SEPs (100%) and twenty-three (85.2%) out of twenty-seven patients with MRI findings of disk herniation at one or two levels, had abnormal SEP findings.

Six patients had MRI evidence of root compression despite normal DSEP and absence of neurologic findings. In 2 of these patients SEP of CPN was abnormal suggestive of root irritation with no exact localization.

In 19 of the 29 patients (65.5%) the nerve roots implicated by SEP abnormalities cor-responded well with those implicated on MRI.

In 7 patients, SEP demonstrated fewer abnormalities than MRI. The clinical im-pression based upon history and neurologic examination in these 7 patients was more concordant with SEP in three, more consistent with MRI in three and equivocal in one. In three patients SEP was a more sensitive test than MRI; 2 cases with two levels of SEP abnormalities (inspite of one level in MRI). In the third case, the SEP was abnormal bilaterally in the presence of unilateral MRI findings. In these 3 patients SEP findings were more consistent with clinical impression.

Correlation with the clinical examination:

Findings on neurologic examination were compared with results of SEP and MRI.

Among 24 patients with focal motor or reflex deficits consistent with lumbosacral radiculopathy, 23 had abnormal MRI and 23 had abnormal SEP.

Among 10 patients with vibratory sense deficits, all had abnormal SEPs. In other cases with abnormal SEP, however, there were not any significant sensory problems.

Among the 29 patients with abnormal SEP the response was absent in seven, prolonged in four and the interside difference was increased in seven. The remainder had some of these findings in combinations. If we consider MRI as the gold standard, sensitivity of SEP would be 88% (29/33).

Discussion

While imaging studies monitor anatomic impairment, SEP assesses physiologic impairment, and there will be disparities plotting one test against the other. Hence, knowledge of sensitivity-specificity in SEP is useful for optimizing the sequence of tests.

False negative and false positive studies are those in which the SEP results did not agree with the imaging comparison standard. In the absence of a gold standard it is impossible to determine whether these are truly false negatives or false positives. Mixed and sensory nerves have been stimulated in an attempt to detect radiculopathies. It is suggested that as each nerve trunk carries fibers, which enter the

spinal canal by several roots, a monoradiculopathy therefore would be masked by a normal SEP mediated by impulses in unaffected roots.[18] This was the case in our study, observing abnormal tibial nerve SEP in 12/25 (42.8%) and abnormal CPN SEP in 16/28 (57%) which is in agreement with the literature.

On the other hand SEP abnormalities from several nerves were found in a high proportion of patients with spinal stenosis: posterior tibial nerve and CPN gave abnormal responses in 83.3% and 100% respective in our experience. Spinal stenosis frequently involves several roots and abnormal SEP from nerve trunks are more likely to be seen.

The generation of cortical evoked potentials is complex. There is a general feeling that lumbosacral radiculopathy is essentially an entrapment neuropathy with secondary vascular compromise.[3] In more peripheral sites entrapment neuropathies are commonly associated with delay in nerve conduction, and the observed delays in SEP latencies may represent a similar phenomenon. Furthermore, the large-diameter afferent fibers that are studied by SEP may be preferentially involved in lumbosarcral radiculopathy[3] perhaps because they are more sensitive to consequences of the underlying pathology or this may be due to anteromedial position of motor fibers to their respective sensory fibers.[20,21] This may be the reason for less frequent EMG findings compared to SEP in radiculopathies.[13,22] Finally, the P1 is a peak, not an onset latency. As such, peak latency measurements may reflect changes in the configuration of the response rather than changes in the latency of its earliest components.[3]

Seyal et al[23] suggested that evaluating peripheral conduction alone, by using the lumbar peak rather than the scalp-recorded potential, would be more useful in this context. In clinical practice, however, a measurable lumbar potential with dermatomal stimulation is often difficult to obtain, even in thin, cooperative patients.

As to the theoretical consideration that spinal cord lesions could be responsible for P1 peak latency prolongation in some of our patients, we have essentially eliminated this concern by using stimulation of adjacent nerves as control.

In conclusion, we think that SEP should be included in electrodiagnostic evaluation of lumbosacral radiculopathy as follows:

1. When EMG is not diagnostic
2. In patients with only sensory signs and symptoms
3. Confirmation of the diagnosis is sought without recourse to invasive procedures
4. Anatomical studies are equivocal or do not explain the symptoms and signs
5. Where psychogenic sensory loss is suspected.

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