ELECTROPHYSIOLOGICAL EVALUATION OF EFFE RENT PATHWAYS FOR LUMBOSACRAL NERVE ROOT AND
CAUDA EQUINA LESIONS USING MOTOR EVOKED POTENTIALS WITH TRANSCUTANEOUS SPINAL ELECTRICAL
STIMULATION

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INTRODUCTION: Diagnostic imaging such as MRI, etc., has clarified the morphological changes in the nerve roots or cauda equina. However, the abnormal imaging findings are not necessarily in agreement with the clinical findings, and it is occasionally difficult to differentiate a responsible lesion if multiple lesions are observed in images. Various types of electrophysiological diagnoses have been investigated. However, segment diagnosis and diagnosis of a single nerve root impairment are very difficult to perform. Mills et al. 1) have demonstrated the possibility of stimulating the spinal cord percutaneously by giving stimulus to cervical skin with a constant-voltage stimulator and recording MEPs from the tibialis anterior muscle. Nevertheless, recording of MEPs from the lower limb muscles has not been applied clinically to date. Therefore, the present study was designed to establish an electrodiagnostic technique which would make it possible to carry out non-invasive evaluation of the mtrp functions and segment diagnosis of the lumbosacral nerve roots and cauda equina.

METHODS: Regarding the patient groups, 31 patients with lumbar disc herniation (LDH), and 37 patients with lumbar spinal canal stenosis (LSCS) were enrolled in the study. The LDH patients were classified, in terms of segment diagnosis. The LSCS patients were classified, in terms of clinical findings, into 1) a nerve root type group; 2) cauda equina type group; 3) mixed type group: patients who exhibited a combination of 1) and 2). Twenty-six healthy subjects (23 males and 3 females) served as the control group. Each subject's spinous process of the spine (L1-S1) in the lumbosacral region was stimulated percutaneously, and MEP was recorded from bilateral femoral vastus medialis (VM), tibialis anterior (TA), extensor digitum brevis (EDB), and abductor hallucis muscle (AH). The recording electrodes used were disc electrodes. The functional electrode was placed in the center of each muscle belly and non-functional electrode was placed on its tendon. A stimulator with stimulus intensity variable up to a maximum of 1200V was used at the maximum upper stimulustensity. Bipolar stimulation electrode was used with the cranial end as the positive electrode and the caudal end as the negative electrode. Each spinal segment was stimulated, and the rising latency for MEP recorded from each lower limb muscle was measured. A difference in latency was obtained for each spinal segment. A difference in L2-S1 latency for MEP recorded from the abductor hallucis muscle which indicated the conduction time of the entire cauda equina was also obtained for evaluation.

RESULTS: The difference in L4-L5 latency of MEPs in the L4-L5 LDH group was 1.38±0.58 ms (mean±SD) for TA in the LDH group, showing a significant prolongation, as compared with 0.57±0.37 ms in the healthy group (p<0.05). The difference in L4-L5 latency for MEPs in the L4-L5 LDH group was 1.70±0.79 ms for EDB in the LDH group, also with a significant prolongation, as compared with 0.63±0.25 ms in the healthy group (p<0.05, Fig.1). The difference in L5-S1 latency of MEPs in the L5-S1 LDH group was 1.26±0.53 ms for AH, with a significant prolongation, as compared with 0.61±0.24 ms in the healthy group (p<0.05). However, no significant difference in L5-S1 latency of MEPs was observed for VM, TA or EDB between the LDH group and the healthy group. A comparison of the difference in L2-S1 latency between the nerve root type patients in the LSCS group (3.40±0.59 ms) and that in the healthy group (3.18±1.04 ms) showed no significant difference. A comparison of the difference in L2-S1 latency between the cauda equina type patients (4.84±1.50 ms) and the mixed type patients (5.73±2.19 ms) in the LSCS group and that in the healthy group showed significant differences from the healthy group and the nerve root type group (p<0.05, Fig.2).

DISCUSSION: For the LDH group, it is important to evaluate MEPs recorded from main dominant lower limb muscles of an impaired nerve root according to hernia-occurrence segments. In other words, it was not the L2-S1 latency, i.e., the cauda equina conduction time, but the prolongation of cranial-caudal latency difference for the hernia-occurrence spinal segment that were useful in diagnosing the nerve root functions. In the LSCS group, MEPs findings varied according to the disease types. MEPs findings in the nerve root type included a prolongation difference in the cranial-caudal latency for MEPs recorded from the dominant nerve root muscles of the stenosed segment, prolonged cauda equina conduction time in the cauda equina type, and a combination of the nerve root type findings and cauda equina type findings in the mixed type. We consider the differences in MEPs findings to be in agreement with the clinical anatomical findings that the cauda equina type was not a localized impairment of the nerve roots but stenosis of the cauda equina as a whole and that the mixed type was a combination of both types.

REFERENCE: