Dermatomally Stimulated Somatosensory Evoked Potentials In Lumbar Disc Herniation

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Abstract : Diagnostic potential of dermatomally stimulated somatosensory evoked potentials (DSSEP) in radiculopathy due to lumbar disc herniation is investigated. Normative data were estimated by statistical analysis of the values obtained by bilateral stimulation of the L4, L5 and S1 dermatomes of 28 healthy volunteers. Latency values beyond 99 % confidence limit, inter-side differences in latencies more than three standard deviations, and an absent potential were considered abnormal. Preoperative DSSEP studies in 15 patients with unilateral radiculopathies due to lumbar disc herniation correctly diagnosed 16 affected roots out of 18 which were subsequently verified by surgery. DSSEP is a reliable diagnostic technique in unilateral radiculopathy due to lumbar disc herniation.

Key Words : Evoked potentials, somatosensory; intervertebral disc displacement

INTRODUCTION

Somatosensory evoked potentials (SSEPs) that reflect conduction of affected impulses through the dorsal roots is a useful method in the electrodiagnostic evaluation of lumbosacral radiculopathy (1,2). Nevertheless, diagnostic value of SSEPs in radiculopathy is limited because of the mixed radicular pattern of the nerve stimulated. The response elicited in functionally normal fibres traversing intact roots may obscure abnormalities resulting from the affected root. Dermatomally stimulated somatosensory evoked potentials (DSSEPs) may have higher diagnostic value than SSEP in monoradiculopathies. However only a few authors have described the use of DSSEPs in radiculopathy due to disc herniation (1,2,5,10,11).

The purpose of this work is to evaluate the diagnostic yield of DSSEP in subjects with surgically verified lumbar radicular affections.

MATERIALS AND METHODS

Materials

The control group consists of 28 healthy volunteers of both sexes (11 females, 17 males) between 21 and 54 years old (mean + standard deviation, 42,2 + 5,3). The patient group consists of 15 subjects (10 females, 5 males) between 28 to 60 years old (mean + standard deviation, 41,6 + 8,5) with suspected unilateral lumbosacral radicular compression (Table I). Cases with bilateral signs and symptoms were excluded.

Methods

DSSEP recordings were made with the subject in the supine position. The room temperature was kept between 22-24°C. A disc electrode was placed at CZ' (between CZ and PZ of the international 10-20 system). The reference electrode was placed at FZ, the ground electrode was at FPZ. A bipolar surface

Tablo I : Clinical Findings in 15 Patients

Patient No, Age-Sex	Duration of Root Pain	Side	Sensory Deficit	Motor Deficit	Ankle Jerk	Knee Jerk
1. 45 F	2 yr	Left	L4,L5,S1	L5	–	++
2. 50 F	6 mo	Left	None	None	++	++
3. 48 F	3 yr	Right	L5,S1	L5	++	++
4. 30 M	5 yr	Left	None	None	++	++
5. 40 F	9 yr	Left	L4,L5	L5	++	++
6. 40 F	2.5 mo	Left	None	L4,L5	++	+
7. 42 F	2 yr	Right	L4,L5,S1	L4,L5	++	++
8. 37 F	3 mo	Right	None	L4,L5	+	++
9. 60 M	20 yr	Left	L5	L5	–	++
10. 28 F	3 mo	Left	L5,S1	L5	–	++
11. 32 F	4 yr	Left	L4	L5	+	++
12. 43 M	1 yr	Left	L4,L5	L4,L5	–	++
13. 45 M	15 dy	Left	None	L5	+	+
14. 35 F	2 yr	Right	L4,L5	None	++	++
15. 50 M	15 dy	Right	L4,L5,S1	None	++	++

M: male, F: female, yr: year, mo: month, dy: day, L: lumbar, S: sacral

electrode was used for stimulation with an interelectrode distance of 2 cm. The cathode was placed proximally. The stimulation point of the dermatome was chosen in accordance with clinically and anatomically defined dermatome borders. For S1 this stimulation point was at the lateral side of the fifth metatarsal bone; for L5 at the medial side of the second metatarsal bone; for L4 at the midpoint of the line between the medial malleolus and medial epicondyle of the tibia. For each dermatome, stimulus intensity was set at three times sensory threshold. The stimulus rate was 2/sec, and pulse duration was 0,1 msec. The data were obtained by standard ENMG equipment (Nihon Kohden MEM 3202, Tokyo, Japan). The amplifier bandpass was 5-250 Hz. The amplification was set to 50 V full scale. Two trials at averaging were recorded each consisting of 256 single stimulus responses, and superimposed to check the constancy.

Needle EMG recordings of the quadriceps femoris and anterior tibial (L4), anterior tibial and extensor digitorum brevis (L5), and gastrocnemius (S1) muscles were made by standard EMG equipment (Nihon Kohden MEM 3202, Tokyo, Japan). Fibrillation, positive sharp wave, and/or reduced recruitment pattern were taken as signs of radicular lesion. Normal peripheral nerve sensory conduction velocity (femoral, peroneal and posterior tibial nerves) was a prerequisite for EMG study.

Sensitivity of DSSEP was estimated as the ratio of number of root lesions detected by DSSEP to the number of all surgically verified root lesions.

RESULTS

Dermatomal cortical SSEPs had a typical "W" configuration. The first positive peak was sharply distinguishable. The time from stimulus to peak was measured as latency (Figure 1). Mean latency values, and interside difference in latency for each dermatome in the control group are shown in Table II. The latency value of each dermatome positively correlated with the subject's height (Fig. 2), but the latency difference between left and right did not.

Criteria of abnormality are shown in Table III.

Affected roots as diagnosed by myelography, CT, EMG, and DSSEP and surgically verified root compressions are shown in Table IV.

Sixteen out of 18 surgically verified affected roots displayed abnormal DSSEP findings according to the criteria in Table III. Sample recordings are shown in Fig. 3.

The diagnostic sensitivity of DSSEP is 88%.

DISCUSSION

The present study was planned and carried out with the aim of checking and correlating DSSEP finding with those of other electrophysiological and radiological methods, and particularly with findings of surgery. Opinions on the diagnostic potential of DSSEP in radiculopathies are divergent. Sedgwick et al. (11), Katifi et al. (5), and Simic (13) state that DSSEP is a useful test in diagnosis and evaluation of root

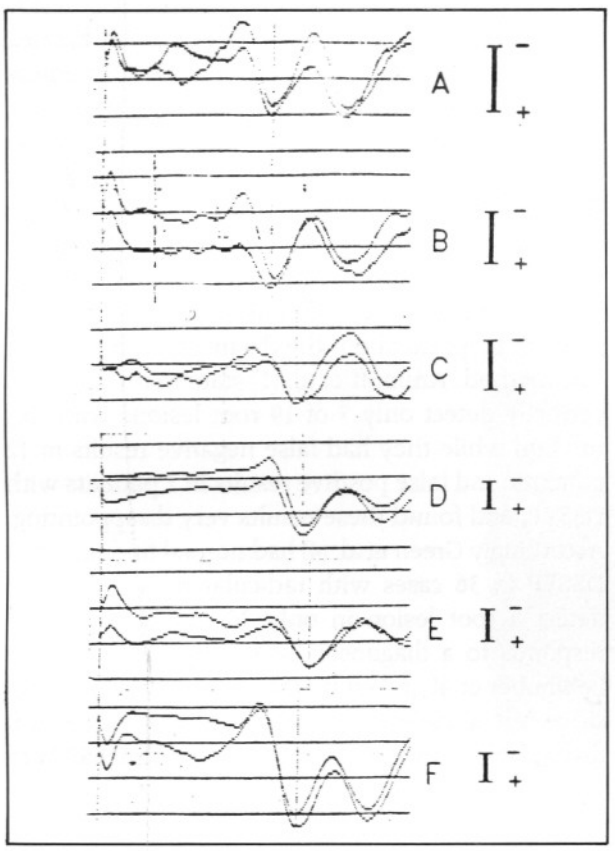

Fig. 1 : DSSEP recordings at different dermatomes. (A and B left and right L4. C and D left and right L5. E left and right S1. respectively. Calibration 40 msec. 1 uV)

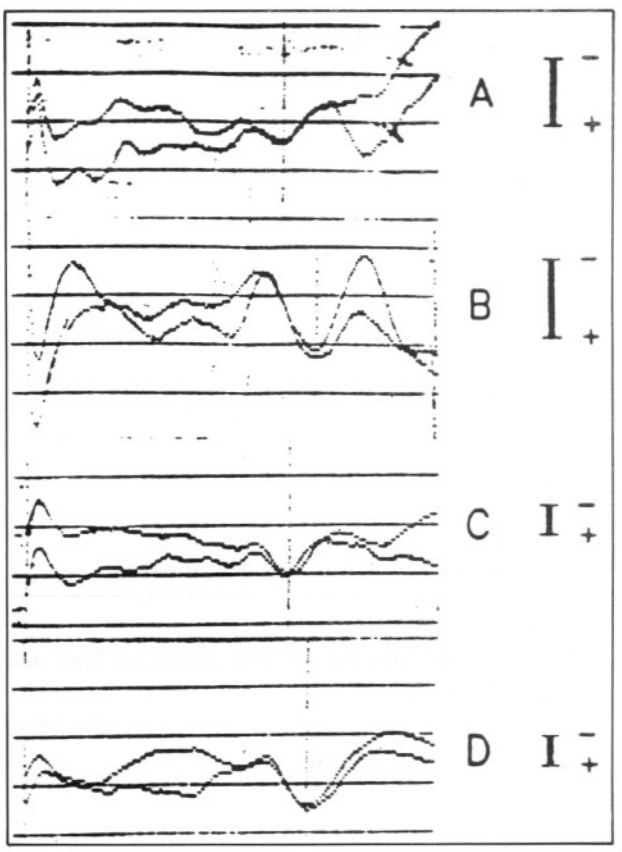

Fig. 3 : Sample recording from patient 14 demonstrating prolonged latencies at right L5 and S1 dermatomes. (A and B left and right L5. C and D left and right S1. repsectively. Calibration 40 msec. 1 uV)

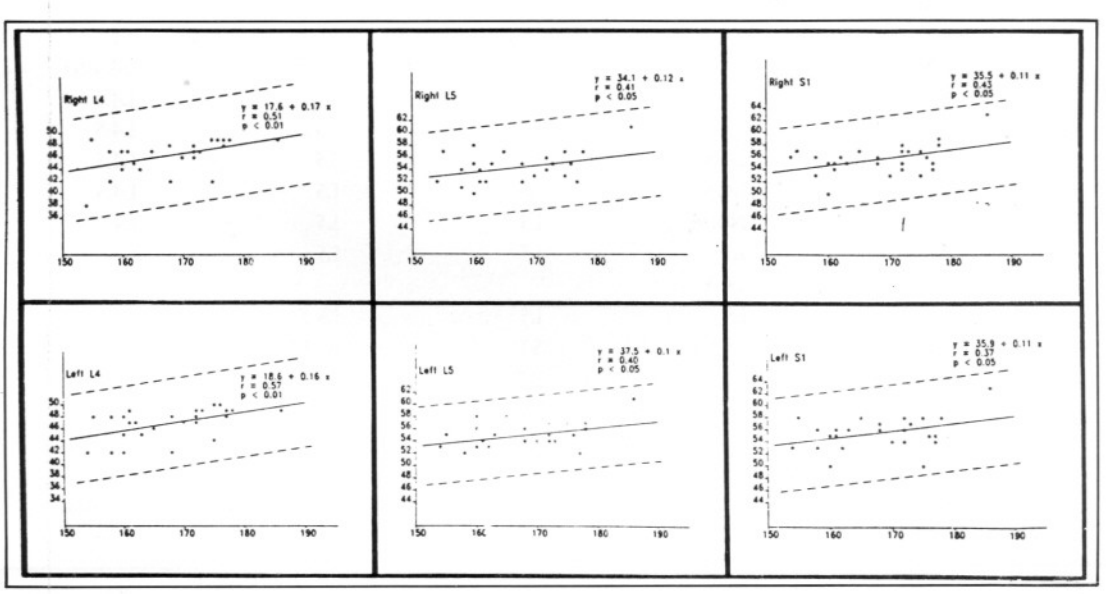

Fig. 2 : Scattergrams of the first positive peak in msec (y-axis) against body length in cm (x-axis) for several dermatomes. The regression line is given as solid, the dotted lines indicate the 99% confidence limits. The regression line formula, the correlation coefficient and its significance are given

Table II : Latency Values and Interside Differences In Latency Values Obtained by Dermatomal Stimulation In 28 Healthy Volunteers*

L4 Right	46,20+2,80
Left	46,20+2,50
Interside Difference	1,14+0,92
L5 Right	54,50+2,40
Left	54,90+2,10
Interside Difference	1,00+1,01
S1 Right	55,60+2,30
Left	55,60+2,60
Interside Difference	0,85+0,93

* Values are given as meanstandard deviation
L: Lumbar, S: Sacral

Table III : Criteria of Abnormality

1. An absent potential
2. A latency value beyond the 99% confidence limit of a given dermatome
3. Interside difference in latency that is more than 3xSD for that particular dermatome

lesions. Scarff et al. (10) reported correct root lesion localization in 35 of 38 surgically verified lumbar disc herniations with this method; normal DSSEP findings were detected in two affected roots (false negative), and contralateral DSSEP pathology was detected in one case (false positive). These authors conclude that DSSEP detected the affected root in 92% of the cases. Borrego et al. (3) also reported the diagnostic sensitivity of this method to be 92% in lumbosacral root lesions. However, Aminoff et al. (1), and Green et al. (4) were sceptical about the diagnostic sensitivity of this method. Aminoff et al. (1) state that they could correctly detect only 5 of 19 root lesions with this method while they had false negative results in 12 patients, and false positive results in 2 patients with DSSEP, and found these results very disappointing. Accordingly Green et al. (4) had normal findings with DSSEP in 36 cases with radicular pain; but could detect a root lesion in only 30 cases, which corresponds to a diagnostic sensitivity figure of 45%. Leblhuber et al. (6,7) state that DSSEP are fairly sensitive but nonspecific in the evaluation of cervical discopathies. Snowden et al. (15) found DSSEPs to

Table IV : Root Lesions Detected by Surgery, DSSEP, Myelography, CT, and EMG

Patients No/Side	Surgery	DSSEP	Myelography	CT	EMG
1 Left	S1	S1	L5	L5	S1
2 Left	L5,S1	L5,S1	L5,S1	L5,S1	L4,5,S1
3 Right	L5	L5	L5	L5	L4,5
4 Left	L5	L5	L5	L5,S1	L4,5
5 Left	L5	L4,5	L5	L5	L4,5
6 Left	L4,5	L4,5	L5	L5	L4,5
7 Right	L5	None	L5	L5	L4,5
8 Right	L5	L5	L5	L5	L4,5
Left		L4,5			
9 Left	L5	L5	L5	L5,S1	L5,S1
10 Left	S1	L5,S1	S1	L5,S1	L5,S1
11 Left	S1	S1	S1	L5,S1	S1
12 Left	L5,S1	L5,S1	L5	L5	L4,5,S1
13 Right	L4	L4	L4	Normal	Normal
14 Right	L5	L5,S1	L5	L5	L4,5
15 Right	L4		L4	L4	Normal
Left		S1			

be 93% sensitive with a 94% positive predictive value in the diagnosis of lumbosacral spinal stenosis. In one study Seyal et al. (12) recorded SSEPs over both spine and scalp following segmental sensory leg stimulation (saphenous, superficial peroneal, and sural nerves that receive contributions predominantly from L3/L4, L5, and S1 roots, respectively), and found that spinal segmental SSEPs were useful in the evaluation of lumbosacral radiculopathies, being more sensitive than scalp recorded segmental SSEPs'.

DSSEP could detect 88% of surgically verified root lesions in our study. This promising result is in contradiction with some previous studies (1,4,6,7) but confirms the views of Scarff et al. (10) views on the diagnostic efficacy of DSSEP.

A higher sensitivity with DSSEP is expected in cases with sensory deficits. DSSEP detected the affected root correctly in 5 cases which did not have sensory deficits. Again in 2 patients (nos 2,4) who presented with only radicular pain and had no motor or sensory deficits DSSEP could detect the affected roots correctly as consequently verified by surgery. The possibility of an inadequate neurological examination or poor cooperation with the patient can not be discarded in these cases. However, we are of the opinion that DSSEP is a useful test especially in patients with non-specific symptoms of radiculopathy, like pain.

In some of our cases (nos 5,10) DSSEP showed at least two root lesions. But at surgery only one root was exposed in accordance with radiological findings. Therefore we could not verify or reject the second root lesion surgically.

Diagnostic values of DSSEP and EMG were comparable (88%) (Table IV). However DSSEP and EMG examinations were normal in one patient (no 7), and two patients (nos 13,15), respectively despite the presence of root lesion at operation. One explanation may be that sensory fibres might be preserved in patient no 7, and motor fibres might be preserved, or acute compression may result in conduction slowing and not axonal loss in patients nos 13,15

Extreme variability of amplitudes of DSSEP in normal subjects precludes the use of this parameter in the diagnosis of pathological conditions (9). In a recent study by Slimp et al. (14) it is reported that comparison of the coefficient of variation between the tibial nerve and L5 and S1 dermatomal responses showed that dermatomal scalp responses were about 25% more variable than the mixed nerve scalp responses, and amplitudes were several times more variable than latencies. This observation was repeated in our study therefore we also disregarded amplitude values in the final evaluation unless an absent potential was obtained.

Although the diagnosis of lumbar disc herniation is straightforward nowadays thanks to imaging techniques with high resolution and accuracy, the authors conclude that DSSEP has a high diagnostic potential in lumbosacral root lesions, and utilization of this noninvasive technique contributes to accurate localization of affected roots.

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