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ORIGINAL REPORT

PHYSICAL EXAMINATION, MAGNETIC RESONANCE IMAGING, AND ELECTRODIAGNOSTIC STUDY OF PATIENTS WITH LUMBOSACRAL DISC HERNIATION OR SPINAL STENOSIS

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Objective: **To compare the clinical implications of electrodiagnostic study with those of magnetic resonance imaging in patients with lumbosacral intervertebral herniated disc or spinal stenosis.**

Design: **Retrospective study of clinical data.**

Patients: **Patients with lumbosacral intervertebral herniated disc or spinal stenosis, diagnosed by clinical assessment and magnetic resonance imaging (MRI), were selected. A total of 753 patients (437 with lumbosacral intervertebral herniated disc and 316 with spinal stenosis) were included in the study.**

Methods: **Clinical data for electrodiagnostic study (EDX) and MRI were compared and the sensitivity and specificity of these studies were evaluated. Among all subjects, 267 had radiculopathy on EDX (EDX (+)) and 486 no radiculopathy (EDX(–)). Furthermore, 391 had root compression on MRI (MRI (+)) and 362 no root compression on MRI (MRI (–)).**

Results: **Patients with EDX (+) showed a significantly higher visual analogue scale score for radiating pain and a higher Oswestry Disability Index than those with EDX (–) in the total subjects group and the lumbosacral intervertebral herniated disc subgroup, and there was a trend toward higher Oswestry Disability Index in the spinal stenosis subgroup. Although patients with MRI (+) also had a higher visual analogue scale for radiating pain than patients with MRI (–) in the total subjects group and the lumbosacral intervertebral herniated disc subgroup, no significant difference was seen in the Oswestry Disability Index. EDX revealed a significant correlation with muscle weakness in the total subjects group and the lumbosacral intervertebral herniated disc subgroup, and trends toward muscle weakness in the spinal stenosis subgroup, whereas there was no such significant correlation for MRI findings in any group. Electrodiagnostic study had a higher specificity in terms of physical examination data than MRI, in spite of its lower sensitivity.**

Conclusion: **Electrodiagnostic study was significantly more correlated with clinical data, especially leg muscle weakness and functional status, and showed a higher specificity than MRI in patients with lumbosacral intervertebral herniated disc or spinal stenosis.**

Key words: lumbosacral radiculopathy; electrodiagnostic study; magnetic resonance imaging; physical examination.

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INTRODUCTION

The initial diagnosis of lumbosacral radiculopathy is based on medical history and physical examination (1). Magnetic resonance imaging (MRI) has frequently been used to evaluate spinal causes of back or radiating pain and to assess the presence of nerve root compression in patients with clinically suspected lumbosacral radiculopathy. MRI is a highly sensitive method for the detection of lesions in the spine because of its excellent imaging of anatomical detail. However, MRI does not provide information about physiological nerve function and has a relatively low specificity. Its clinical implications are questionable because abnormalities detected with MRI, such as herniated intervertebral disc (HIVD) or spinal stenosis (SS), are frequently found in asymptomatic individuals or are irrelevant to the patients' symptoms (2–4).

Therefore, a diagnostic method that is more closely related to patients' symptoms and has a high specificity is required to evaluate subjects with a view to determining the appropriate therapeutic options (5, 6). Electrodiagnostic study (EDX), including needle electromyography (EMG), is a specific test to assess the physiological functions of nerve roots or peripheral nerves. The results of EDX correspond better with the clinical manifestation than do the results of MRI (7–10). Although EDX cannot be used to identify underlying causes, such as tumour, HIVD or SS, which radiological studies can, abnormal findings in EDX help in choosing the best therapeutic option, irrespective of the presence of MRI abnormalities (8). In addition, EDX can be used to differentiate among numerous other neuromuscular disorders, such as motor neurone disease, polyneuropathy or myopathy, which are not included in the field of spinal disorders (11). Therefore, EDX is regarded as a useful method for evaluating patients with lumbosacral radiculopathy, in combination with physical examination and radiological evaluation, including MRI (12).

The aim of this study was to examine the clinical implications of EDX in relation to clinical data, such as pain intensity,

functional status and physical examination data, in comparison with MRI results in symptomatic patients with lumbosacral HIVD or SS.

METHODS

Among the patients who underwent EDX for diagnosis of lumbosacral radiculopathy from 2007 to 2009 at department of physical medicine and rehabilitation of Wooridul spine hospital, those who fulfilled the following criteria were included in this study; age range 20–80 years, lower back pain or radiating pain for at least 2 months, diagnosis of lumbosacral HIVD or SS based on MRI and clinical manifestation, referral to department of physical medicine and rehabilitation for EDX. Radiating pain was regarded as pain radiating into the leg below the buttock (6). Initially, 1,200 patients were recruited. MRI (Philips eletronic, NV, USA) was performed using a standardized lumbar spine protocol (sagittal and transverse T1 and T2 weighted sequences with 4-mm slice thickness) with an Intera 1.5T unit. MRI findings were interpreted by neuroradiologists who had no knowledge of the clinical information and EDX results (Gwangwon medical, Seoul, South Korea) (8). HIVD or SS was diagnosed in the presence of significant MRI findings indicative of these conditions and if clinical manifestations were considered compatible with MRI results. The presence or absence of nerve root compression identified by MRI was defined as the outcome measure for analysis.

Exclusion criteria were: diabetes; a history of heavy alcohol consumption; and a history of lower back surgery (13, 14). The fol-

Table I. *Comparison of age, sex ratio, duration of symptoms, visual analogue scale (VAS), and Oswestry Disability Index (ODI) (%) between radiculopathy seen in electrodiagnostic study (EDX) (+) and no radiculopathy seen in EDX (EDX) (–), as well as magnetic resonance imaging (MRI) (+) and MRI (–)*

	EDX (–) [*n*, total]	EDX (+) [*n*, total]	*p*-value	MRI (–) [*n*, total]	MRI (+) [*n*, total]	*p*-value
Age, years, mean (SD)						
Total	59.8 (15.8) [486]	56.2 (15.6) [267]	0.488	54.1 (15.2) [362]	53.3 (17.3) [391]	0.476
HIVD	54.9 (15.6) [271]	48.2 (16.3) [166]	0.332	45.9 (12.3) [239]	44 (12.1) [198]	0.532
SS	65.2 (11.5) [215]	64.5 (9.1) [101]	0.513	62.1 (10.6) [123]	63.2 (10.1) [193]	0.415
Sex ratio (M/F), *n*						
Total	180/182 [486]	200/191 [267]	0.61	258/226 [362]	152/113 [391]	0.323
HIVD	130/109 [271]	114/83 [166]	0.498	141/130 [239]	83/82 [198]	0.801
SS	50/72 [215]	86/108 [101]	0.415	85/128 [123]	49/51 [193]	0.142
Duration of symptoms, months, mean (SD)						
Total	5 (2.12) [486]	4 (2.10) [267]	0.188	5 (3.12) [362]	4 (2.8) [391]	0.460
HIVD	4 (2.9) [271]	3 (2.6) [166]	0.440	4 (2.9) [239]	3 (2.6) [198]	0.537
SS	6 (3.12) [215]	6 (3.12) [101]	0.793	6 (3.12) [123]	6 (3.12) [193]	0.947
VAS for back pain, mean (SD)						
Total	5.6 (2.7) [200]	5.4 (2.8) [273]	0.327	5.6 (2.8) [268]	5.3 (2.7) [205]	0.191
HIVD	5.4 (2.6) [126]	5.1 (2.8) [134]	0.363	5.3 (2.8) [131]	5.3 (2.6) [129]	0.877
SS	5.9 (2.8) [74]	5.6 (2.7) [139]	0.403	5.9 (2.7) [137]	5.4 (2.8) [76]	0.147
VAS for radiating pain, mean (SD)						
Total	7.2 (2.5) [200]	7.8 (1.9) [273]	0.015*	7.4 (2.3) [268]	7.8 (2.3) [205]	0.020*
HIVD	7 (2.6) [126]	7.9 (1.7) [134]	0.029*	7.2 (2.5) [131]	7.8 (1.9) [129]	0.034*
SS	7.5 (2.2) [74]	7.7 (2.1) [139]	0.282	7.6 (2.1) [137]	7.8 (2.3) [76]	0.163
ODI, %, mean (SD)						
Total	57.8 (18.1) [200]	63.2 (17.5) [273]	0.003*	59.7 (17.8) [268]	62.6 (18) [205]	0.101
HIVD	58.1 (19.1) [126]	64.3 (17) [134]	0.009*	59.1 (18.2) [131]	63.5 (18.2) [129]	0.055
SS	57.4 (16.3) [74]	62.2 (17.9) [139]	0.059	60.3 (17.5) [137]	61 (17.6) [76]	0.925

*$p<0.05$.

EDX (–): no radiculopathy seen on EDX; EDX (+): radiculopathy seen on EDX; MRI: magnetic resonance imaging; MRI (–): no root compression seen on MRI; MRI (+): root compression seen on MRI; HIVD: herniation of intervertebral disc; SS: spinal stenosis; VAS: visual analogue scale; ODI: Oswestry Disability Index.

lowing physical examination data were assessed: (*i*) a neurological examination, including manual muscle testing, sensation (vibration and pinprick), and reflex assessments; (*ii*) a musculoskeletal examination; and (*iii*) straight-leg raise (SLR) (15). In addition, patient questionnaire data, including the visual analogue scale (VAS) and the Korean version of the Oswestry Disability Index (ODI) were obtained (16). VAS ranging from 0 (no pain) to 10 (excruciating pain) were obtained to assess the severity of back and radiating pain. ODI (%) was calculated to assess the functional status of each patient. The ODI comprises 10 sections, each with a total score of 5. The first statement was scored as 0 and the last statement was scored as 5. If all 10 sections were completed by each patient, the score was calculated as a percentage. For example, if the total score from 10 sections for 1 patient was 16, the score of that patient would be 32% (16/50 (maximal possible score) × 100) (17). The VAS and ODI have been validated as useful measurements for assessing degree of pain and functional status, respectively (18).

Standardized EDX consisted of: (*i*) lower-limb motor nerve conduction study, (*ii*) lower-limb sensory nerve conduction study, and (*iii*) EMG with bipolar needles. EDX was performed by an experienced physiatrist who was certified by the American Board of Electrodiagnostic Medicine. We chose to examine the 5 leg muscles per 1 leg and the lumbar paraspinal muscles, based on the work of Dillingham et al. (15). The leg muscles to be tested were chosen from the adductor longus (L2–4), tibialis posterior (L4–5), medial gastrocnemius (L5–S2), extensor hallucis longus (L5–S1), tibialis anterior (L4–5), vastus medialis (L2–4), and tensor fascia lata (L4–S1) (13, 19). For each muscle, 10 motor unit action potentials (MUAPs) were evaluated at submaximal voluntary activation. The number of polyphasic motor units (i.e. 5 or more phases), duration, amplitude, and recruitment were recorded for each muscle. Muscles within the appropriate myotome and adjacent myotomes (above and below) were selected based on clinical suspicion. Any denervation or reinnervation activity was noted. The duration was measured from the initial baseline deflection to the return to baseline and was compared with normal values. MUAPs with increased duration were taken as a sign of reinnervation. The presence of positive sharp waves or fibrillations in two or more areas of sampling per muscle were considered as proof of ongoing denervation (8).

Lumbosacral radiculopathy was defined by the presence of abnormalities in two or more muscles innervated at the same nerve root level but by different peripheral nerves. Non-paraspinal lower-limb muscles were considered abnormal if they demonstrated the following characteristics: (*i*) positive sharp waves, (*ii*) fibrillation potentials, (*iii*) complex repetitive discharges, (*iv*) high-amplitude, long-duration MUAPs, (*v*) increased polyphasic motor-unit action potentials (> 30%), or (*vi*) reduced neuropathic recruitment. Paraspinal muscles were considered abnormal if they showed fibrillation potentials, positive sharp waves, or complex repetitive discharges (15). Patients who demonstrated evidence of other neuromuscular diseases, such as peripheral neuropathy, motor neurone disease, cauda equine syndrome, or myopathy, were excluded from the analysis of this study.

A final total of 753 patients (437 with HIVD and 316 with SS) were included in this study. Among all subjects, 267 (166 with HIVD and 101 with SS) had evidence of radiculopathy on EDX (EDX (+)) and 486 (271 with HIVD and 215 with SS) had no evidence of radiculopathy (EDX (–)). Furthermore, 391 (198 with HIVD and 193 with SS) were found to have root compression seen on MRI (MRI (+)) and 362 (239 with HIVD and 123 with SS) showed no root compression on MRI (MRI (–)).

Statistical analysis

Student's *t*-test was conducted to compare age, VAS for back and leg pain, and ODI (%) and a Mann-Whitney test was performed to compare duration of symptoms between EDX (+) and EDX (–) as well as between MRI (+) and MRI (–). χ^2 with Fisher's exact test was used to analyse gender difference. Multiple logistic regression test was used to evaluate the statistical significance of EDX and MRI, respectively, in relation to physical examination data. McNemar's test was also utilized to compare sensitivity and specificity between EDX and MRI. These tests were conducted on the data for total patients, as well as for subgroups such as HIVD, respectively. The results were considered statistically significant if the *p*-value was less than 0.05.

RESULTS

EDX (+) patients had a significantly higher VAS for radiating pain and ODI (%) than EDX (–) patients, for both the total subjects group and the HIVD subgroup. EDX (+) patients also

Table II. *Relationship between physical examination and root compression seen on magnetic resonance imaging (MRI) or radiculopathy seen on electrodiagnostic study (EDX) analysed by multiple logistic regression analysis*

	MRI			EDX		
Dependent variables	*p*-value	Odds ratio	95% CI lower–upper	*p*-value	Odds ratio	95% CI lower–upper
Positive SLR						
Total	<0.001*	5.400	3.270–8.900	<0.001*	4.184	2.784–6.289
HIVD	<0.001*	4.630	2.560–8.380	<0.001*	4.150	2.400–7.180
SS	<0.001*	8.910	3.050–26.050	<0.001*	4.020	2.170–7.440
Muscle weakness of lower limb						
Total	0.420	0.861	0.598–1.239	<0.001*	4.350	3.020–6.250
HIVD	0.380	1.223	0.782–1.912	<0.001*	5.940	3.740–9.420
SS	0.590	1.261	0.540–2.960	0.060	2.760	0.960–7.980
Decreased sensation of lower limb						
Total	<0.001*	2.240	1.580–3.180	<0.001*	3.330	2.360–4.690
HIVD	<0.001*	2.540	1.630–3.950	<0.001*	3.240	2.080–5.060
SS	<0.001*	2.530	1.340–4.790	<0.001*	2.980	1.700–5.200
Decreased deep tendon reflex of lower limb						
Total	<0.001*	3.600	2.000–6.470	<0.001*	5.400	3.260–8.930
HIVD	<0.001*	3.360	1.690–6.680	<0.001*	5.110	2.620–9.960
SS	0.010*	5.110	1.460–17.950	<0.001*	5.410	2.500–11.730

*$p < 0.05$.

SLR: straight-leg raising; HIVD: herniation of intervertebral disc; SS: spinal stenosis; CI: confidence interval.

showed trends toward higher ODI (%) than EDX (–) patients in the SS subgroup, but this was not statistically significant. MRI (+) patients also had higher VAS for radiating pain than MRI (–) patients in the total subjects group and the HIVD subgroup. But MRI (+) patients did not show any significant difference in ODI (%) (Table I).

Multiple logistic regression analysis demonstrated a significant difference in muscle weakness between MRI and EDX. EDX showed a significant correlation with muscle weakness in the total subjects group and HIVD subgroup and trends towards muscle weakness in the SS subgroup, although this did not show statistical significance ($p = 0.060$) . However, MRI did not show significant correlation with muscle weakness in any groups. For other clinical parameters, both MRI and EDX revealed significant correlations (Table II).

EDX generally showed higher specificity and lower sensitivity in predicting positive physical findings than did MRI in the total group, and the HIVD and the SS subgroups. It was notable that EDX showed higher specificity with statistical significance for all clinical parameters in the total group, and the HIVD and the SS subgroups (Table III).

Overall, 208 patients (27.6%) were both MRI (+) and EDX (+), while 303 patients (40.2%) were MRI (–) and EDX (–). There were 59 patients (7.84%) who were EDX (+) and MRI (–) and 183 patients (24.3%) who were EDX (–) and MRI (+). Approximately 22% of EDX (+) patients were also MRI (–) and 46.8% of MRI (+) patients were EDX (–). The McNemar's test indicated that EDX had higher specificity and lower sensitivity, with statistical significance (Table IV).

DISCUSSION

Radiological studies using MRI only reveal structural abnormalities, which may also be present in asymptomatic subjects or may be unrelated to the clinical findings. Therefore, consideration of clinical and functional status in combination with radiological findings is necessary in order to obtain an accurate diagnosis and use a concise approach to the patient

Table III. *Comparison of specificity and sensitivity in terms of physical findings between root compression seen on magnetic resonance imaging (MRI) (+) and no root compression seen on MRI (–) as well as radiculopathy seen on electrodiagnostic study (EDX) (+) and no radiculopathy seen on EDX (–)*

	MRI (–) EDX (–)	MRI (–) EDX (+)	MRI (+) EDX (–)	MRI (+) EDX (+)	MRI sensitivity	EDX sensitivity	95% CI lower–upper	*p*-value
Comparison of sensitivity between MRI and EDX								
SLR (+)								
Total	10	12	38	101	0.863	0.702	0.079–0.243	<0.001*
HIVD	7	11	18	56	0.804	0.728	–0.038–0.190	0.265
SS	3	1	20	45	0.942	0.667	0.162–0.388	0.000*
Muscle weakness of lower limb (+)								
Total	58	35	37	98	0.592	0.583	–0.064–0.082	0.906
HIVD	53	35	27	86	0.562	0.602	–0.037–0.117	0.374
SS	5	0	10	12	0.815	0.444	0.189–0.553	0.002*
Decreased sensation of lower limb (+)								
Total	46	28	61	120	0.71	0.58	0.059–0.201	0.001*
HIVD	33	24	33	74	0.652	0.598	–0.036–0.144	0.289
SS	13	4	28	46	0.813	0.549	0.155–0.373	<0.001*
Decreased deep tendon reflex of lower limb (+)								
Total	7	9	18	72	0.849	0.764	–0.010–0.180	0.122
HIVD	4	9	10	40	0.794	0.778	–0.120–0.152	1.000
SS	3	0	8	32	0.93	0.744	0.070–0.302	0.008
Comparison of specificity between MRI and EDX								
SLR (–)								
Total	293	47	145	107	0.574	0.74	0.122–0.210	<0.001*
HIVD	183	38	63	61	0.641	0.713	0.015–0.129	0.017*
SS	110	9	82	46	0.482	0.777	0.229–0.361	<0.001*
Muscle weakness of lower limb (–)								
Total	245	24	146	110	0.512	0.745	0.189–0.277	<0.001*
HIVD	137	14	54	31	0.64	0.809	0.104–0.234	<0.001*
SS	108	10	92	79	0.408	0.692	0.224–0.344	<0.001*
Decreased sensation of lower limb (–)								
Total	257	31	122	88	0.578	0.761	0.137–0.229	<0.001*
HIVD	157	25	48	43	0.667	0.751	0.023–0.145	<0.001*
SS	100	6	74	45	0.471	0.773	0.235–0.369	<0.001*
Decreased deep tendon reflex of lower limb (–)								
Total	296	50	165	136	0.535	0.713	0.136–0.220	<0.001*
HIVD	186	40	71	77	0.604	0.687	0.028–0.138	0.004*
SS	110	10	94	59	0.44	0.747	0.244–0.370	<0.001*

*$p < 0.05$.

MRI (–): no root compression seen on MRI; MRI (+): root compression seen on MRI; EDX (–): no radiculopathy seen on EDX; EDX (+): radiculopathy seen on EDX; SLR: straight-leg raising; HIVD: herniation of intervertebral disc; SS: spinal stenosis; CI: confidence interval.

Table IV. *Comparison of specificity and sensitivity between root compression seen on magnetic resonance imaging (MRI) and radiculopathy seen on electrodiagnostic study (EDX) using McNemar's test*

	EDX (–)		EDX (+)		EDX to MRI		MRI to EDX				
	MRI (+)	MRI (–)	MRI (+)	MRI (–)	Sensitivity	Specificity	Sensitivity	Specificity	Odds ratio	95% CI	*p*-value
Total	183	303	208	59	0.532	0.837	0.779	0.623	5.84	4.14–8.22	0.007*
HIVD	81	190	117	49	0.591	0.795	0.705	0.701	5.6	3.67–8.55	<0.001*
SS	102	113	91	10	0.472	0.919	0.901	0.526	10.08	4.98–20.41	<0.001*

*$p < 0.05$.

EDX (–): no radiculopathy seen on EDX; EDX (+): radiculopathy seen on EDX; MRI (–): no root compression seen on MRI; MRI (+): root compression seen on MRI; HIVD: herniation of intervertebral disc; SS: spinal stenosis; CI: confidence interval.

(20). EDX, including EMG, assesses the physiological and functional status of peripheral nervous systems rather than anatomical and structural evaluation, and provides information about the pathophysiological mechanism of the pain, which is helpful in choosing appropriate therapeutic options. EDX reveals clinically relevant nerve dysfunction in patients whose radiological findings are normal or appear to be irrelevant to the clinical findings. It has been reported that EDX has a higher specificity than MRI in asymptomatic subjects with SS (8, 10, 21). In addition, a previous study identified that EDX had the ability to differentiate clinical SS from non-specific back pain without SS as well as normal control subjects (11). EDX can also be used clinically to identify non-spinal causes of leg pain or neurological deficits, such as peripheral neuropathy and motor neurone disease (11).

The present study demonstrated the useful characteristics of EDX. First, EDX showed a higher clinical relevance than MRI. EDX demonstrated a more significant correlation with lower limb muscle weakness and poorer functionality than did MRI in the total group and the HIVD subgroup and showed trends toward lower limb muscle weakness and poor functionality in the SS subgroup. This property of EDX helped the physician to confirm the lesion identified by EDX was indeed the source of pain (21). Secondly, EDX generally showed higher specificity in relation to positive physical examination results than did MRI. MRI frequently showed false positive findings, which might lead to inappropriate treatment. The higher specificity and lower level of false positivity of EDX could compensate for this drawback of MRI and play an important role in steering patients toward appropriate treatments and preventing unnecessary intervention (11). Thirdly, EDX could also be used to identify patients with motor neurone disease, peripheral neuropathy, and myopathy, who were excluded from this study during the process of subject recruitment. These characteristics indicate that EDX can play an important role in the determination of appropriate treatments for patients, prevention of unnecessary interventions, and detection of treatable alternatives or complementary diagnoses (11, 22).

Multiple logistic regression revealed that both MRI and EDX provided significant diagnostic information independent of each other for all physical examination variables except for lower limb muscle weakness. However, EDX had a closer correlation with lower limb muscle weakness, than did MRI. This was explained by the fact that EDX abnormalities were dependent on the loss of motor axons (7). In addition, lower limb muscle strength was closely related to functional status. Consequently, EDX (+) showed a significant correlation with lower functionality, which was expressed as higher ODI (%).

Although EDX correlated significantly with the radiological findings, EDX does not always correspond with them. In concordance with clinical suspicion it has been reported that approximately 7% of EDX (+) patients were MRI (–) and 26% of MRI (+) patients were EDX (–) (8). Our study showed that 22.1% of EDX (+) patients were MRI (–) and 46.8% of MRI (+) patients were EDX (–). These discrepancies can be explained by several hypotheses. Inflammation or vascular compression around the root sheath is not always detected by EDX or MRI despite the presence of radicular pain. Persistent denervation activity, caused by inflammatory infiltration or after resolved herniated disc, may have contributed to EDX (+) and MRI (–) findings. Furthermore, demyelination of the nerve root or slow ongoing denervation processes that do not outpace reinnervation may have led to a EDX (–) result, despite MRI (+) status. Abnormal spinal movements or instability may contribute to symptoms, but the static nature of the lumbar MRI may limit its usefulness in this disorder (8, 14).

This study had limitations related to its retrospective design. First, although all EDXs were conducted by one physiatrist, other physical examination data were obtained by several physicians, and therefore there may be inter-individual differences in these results. Secondly, only those patients who had undergone both MRI and EDX were analysed. Among the patients who were diagnosed with lumbosacral HIVD and SS by MRI, there were patients who did not undergo EDX, and consequently were not included in this study. A pre-planned prospective study could include all patients who were diagnosed with lumbosacral HIVD and SS. Thirdly, this study had a retrospective design, and there was substantial number of patients who did not undergo VAS or ODI, which may reduce the statistical power of comparison of VAS and ODI.

In conclusion, in symptomatic patients with lumbosacral HIVD or SS, EDX was significantly more correlated with clinical data than was MRI. In particular, EDX was significantly correlated with leg muscle weakness and lower functionality and showed better specificity than MRI for the assessment of physical findings. Therefore, EDX may be a useful diagnostic tool to establish management protocols.

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