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Agreement of electrodiagnosis, clinical findings and MRI in patients with low back pain

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ABSTRACT

Background and Purpose: Disc herniation leading to radiculopathy is one of the important differential diagnosis of low back pain which needs specific medical care. Radiculopathies can be initially diagnosed by history taking and physical examination. However role of other diagnostic methods like Magnetic resonance imaging (MRI) and Electromyography (EMG) in narrowing differential diagnosis is warranted when clinical data are inconsistent or inadequate. In this study we evaluated level of agreements among three methods of radiculopathy diagnosis including EMG, MRI and physical exam.

Methods: This study is a comparative cross sectional study on 384 patients which was performed among patients who were referred to electrodiagnosis center for their back pain**.** Results from 3 questionnaires that filled by neurosurgeon for clinical results, radiologist for MRI findings and neurologist for electrodiagnosis findings were psychometrically analyzed using Kappa index for agreement among three methods.

Results: From the 384 cases studied, MRI were successful in 90.6% (348 cases) to identify radiculopathy and EMG and clinic with 76.6% (295 cases) and 70.5% (286 patients), respectively. EMG and MRI have agreed in 76.8% of cases in the diagnosis of radiculopathy. MRI and clinical data in 69.7% of cases (Pvalue<0.940) and EMG and clinical data in 62.7% of cases (Pvalue< 0.843) have agreed but they were not statistically significant.

Conclusion: Study results show that MRI is the best diagnostic tool for evaluating the presence of radiculopathy but EMG could also be used instead of MRI in radiculopathy diagnosis. Since EMG is more invasive than MRI, EMG is better to be considered as a second diagnostic tool.

Keywords: Electrodiagnosis; Physical Examination; Back Pain; Magnetic Resonance Imaging

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INTRODUCTION

Low back pain is the second most common reason of medical counseling in the United States and the most prevalent etiology of disability in patients under the age of 45 [1]. Regarding different strategies recommended for different pathologies of low back pain, appropriate and early diagnosis of pain origin is important. Disc herniation leading to radiculopathy is one of the important differential diagnosis of low back pain which needs specific medical care[2]. Radiculopathies can be initially diagnosed by history taking and physical examination however the role of other diagnostic methods like Magnetic Resonance Imaging (MRI) and Electromyography (EMG) in narrowing differential diagnosis is warranted when

clinical data are inconsistent or inadequate.

MRI with its excellent capability of diagnosis of anatomical lesions is considered as preferred method for diagnosis of radiculopathies among other imaging techniques. However its inability in detection of physiological abnormalities as well as studies reporting diagnosis of spinal stenosis and herniated intervertebral disc among asymptomatic individuals necessitates application of other diagnostic methods. Furthermore, MRI could be misleading by showing some incidental herniations irrelevant to patient's symptoms[3].

Electrodiagnosis including EMG is another method of testing which could be used instead of MRI[4]. Although EMG is able to detect physiological abnormalities like motor radiculopathies, they are not able to address origin and exact etiology of patients' symptoms (e.g., disc herniation and tumor). Furthermore, needing for patient cooperation during EMG is another potential disadvantage, hence, it seems that combination of methods for appropriate diagnosis of radiculopathies and their origins are warranted for preventing from being misled by a single test.

Although most of patients are being treated with ambulatory methods like oral agents, surgery is the best treatment choice in case of some patients. For this reason clinical judgment in admitting patients to surgery or treating them with ambulatory methods is quite important[5].

Differential diagnosis of low back pain can be classified as neuropathic such as lumbosacral disc herniation or mechanical. Muscular and skeletal issue is the most common etiology. Low back pain could also be triggered by kidneys, bladder and abdominal viscera[6]. Back pain could be easily diagnosed by history taking and physical examination but in some cases neurologists and neurosurgeons prefer to use diagnostic tests including lumbar MRI, radiograph from lumbar vertebrae, blood tests and EMG[7, 8].

Low back pain with radiation to thighs and lower extremities could be a sign of radiculopathy even without presenting other symptoms such as sensory or motor or reflex abnormalities. Diagnosis can be confirmed by MRI showing disc herniation compressing neural roots causing patient's symptoms. On the other hand MRI could show some incidental herniations irrelevant to patient's symptoms and might be misleading in diagnostic procedure[3]. Electrodiagnosis is another diagnostic test which can be used instead of MRI[4]. Radiculopathy is one of the most common reason of patients' referral to electrodiagnosis center[9]. Electrodiagnosis study includes 1. studying sensory and motor nerve conduction 2. examination of delayed F and H waves responses, and 3. needle EMG that is the most important part.

Although electrodiagnostic tests are routinely being performed in patients with low back pain, to our knowledge there is no study comparing diagnostic findings and consistency of electrodiagnostic test and MRI as well as physical examination. For this reason we conducted this study in order to assess consistency between MRI electrodiagnostic test and clinical manifestations of patients with symptoms of radiculopathy. In this study we evaluated level of agreements among three methods of radiculopathy diagnosis including EMG, MRI and physical exam and showed the different capabilities of each test in diagnosis of radiculopathy characters.

MATERIALS AND METHODS

This study is a comparative cross sectional study on 384 patients which was performed among patients who were referred to our electrodiagnosis center for their back pain in Poursina Hospital, Rasht, Iran. Exclusion criteria were 1. history of previous lumbar spinal surgery, 2. evidence of possible myopathy or neuropathy in patient's history, physical exam or electrodiagnostic tests 3. incomplete performance of electrodiagnostic tests due to patient's intolerance, and 4. if MRI was not performed or it was contraindicated on the patient.

Sample size was calculated with kappa index calculation according to a study by Lauder TD et al as 384 (95% confidence interval) with 86% to 41% being the maximum and minimum of sensitivity and 63% to 12% being maximum and minimum of specificity, respectively.

Patients were visited by a neurosurgeon. Neurosurgeon took history of patients' symptoms including type, duration and location of the pain, time of pain onset, radiation or any associative factors (numbness, muscle weakness or any sense of abnormality) in patients' feet. A full neurological physical exam also was performed including sensory and motor exam, Lasègue's sign and muscle tendon reflexes. Diagnosis was made according to patients' history and physical exam. Diagnosis includes existent or non-existent radiculopathy, location (sensory nerve root) and severity of radiculopathy.

Severity of radiculopathy was classified into 0 (no radiculopathy), 1 (radicular pain without sensory or motor symptoms), 2 (radicular pain with mild sensory or motor symptoms), and 3 (radicular pain with severe sensory loss and motor dysfunction)[10]. The results and patients' demographic data were entered to special questionnaires that were designed for the study. Patients were referred to

electrodiagnostic center in Poursina hospital as well as an MRI center to follow diagnostic procedures of the study.

MRIs were interpreted by a radiologist and results of possible radiculopathy, impaired sensory nerve root, severity of injury or any other incidental findings, were entered to a separate questionnaire designed for this manner. Severity of radiculopathy was classified depending on the extent of disc herniation and the extent of tightness on nerve root foramen into 0 (normal), 1 (33% tightness or less), 2 (34%-66% tightness), and 3 (66% tightness or more) [11].

Electrodiagnostic tests were performed in Poursina hospital by a neurologist. The tests include 1. studying F and H waves and motor nerve conduction in peroneal and posterior tibialis nerves, 2. studying sensory nerve conduction in superficial peroneal and sural nerves and finally needle EMG with concentric needles which was performed on gastrocnemius, posterior tibialis, peroneal (peroneus longus), quadriceps and paraspinal muscles in both extremities and other muscles if indicated. Results were reported as existent or nonexistent radiculopathy, sensory nerve root which was impaired and severity of injury. Severity of injury was classified depending on the extent of amplitude response drop in patient's peroneal and posterior tibialis motor response and amount of axonal damage in EMG to 0 (no radiculopathy), 1 (radiculopathy without axonal degradation), 2 (radiculopathy with mild axonal degradation), and 3 (radiculopathy with severe axonal degradation)[12]. Results from EMG were entered to a separate questionnaire. Results from 3 questionnaires that were filled by neurosurgeon, radiologist and neurologist were psychometrically analyzed using Kappa index for agreement among three methods.

Ethical considerations

This study was approved by Gilan University of Medical sciences' ethical committee.

RESULTS

In this study 384 patients with low back pain were involved. They were studied by three diagnostic methods (history and physical exam, MRI and EMG) in order to diagnose existence or not existence of radiculopathy and its severity and also determining the sensory nerve (roots) which was impaired. From the 384 cases studied, MRI were successful in 90.6% (348 cases) to identify radiculopathy and EMG and clinic with 76.6% (295 cases) and 70.5% (286 patients), respectively (Table 1).

EMG and MRI have agreed in 76.8% of cases in the diagnosis of radiculopathy. According to Coefficient of concordance of Kappa the value was statistically significant (Kappa = 0.178 and Pvalue<0.0001). MRI and clinical data in 69.7% of cases (Pvalue<0.940) and EMG and clinical data in 62.7% of cases (P value< 0.843) have agreed but they were not statistically significant.

All MRI, EMG and clinic have 54.7% agreement with each other (Table 2; Figure 1).

In this study, to assess the severity and location of radiculopathy, 546 nerve Roots has been studied. In determination of radiculopathy severity, MRI has

Table 1. Percentage of diagnostic cases using MRI, EMG and clinical examination.

	Negative for radiculopathy		Positive for radiculopathy		Total	
	number	%	number	%	Number	%
Radiculopathy by MRI	36	9.4	348	90.6	384	100
Radiculopathy by EMG	89	23.2	295	76.8	384	100
Radiculopathy by Clinically	98	25.5	286	74.5	384	100

Table 2. Frequency distribution agreement individuals with radiculopathy based on EMG and MRI diagnosis and clinical examinations.

Radiculopathy by Clinically	Radiculopathy by MRI		Total
	NO	YES	
NO			
Radiculopathy by EMG			
NO	2 (0.52%)	20 (5.21%)	22 (5.73%)
YES	7 (1.82%)	69 (17.97%)	76 (19.79%)
Total	9 (2.34%)	89 (23.18%)	98 (25.52%)
YES			
Radiculopathy by EMG			
NO	16 (4.17%)	51 (13.28%)	67 (17.45%)
YES	11 (2.86%)	208 (54.17%)	219 (57.03%)
Total	27 (7.03%)	259 (67.45%)	286 (74.48%)

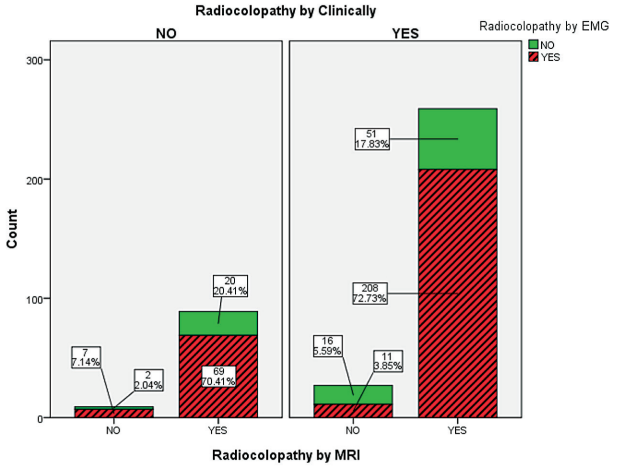

Figure 1. Frequency distribution of agreement in individuals with radiculopathy based on EMG and MRI diagnosis and clinical examinations.

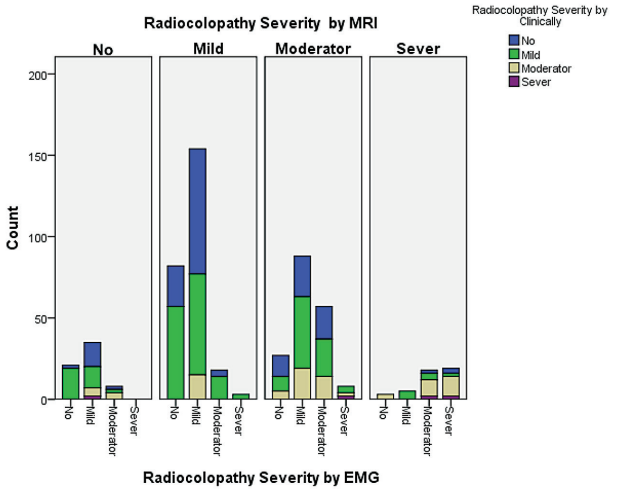

Figure 2. Frequency distribution of severity of radiculopathy based on EMG and MRI and clinical findings.

significant agreement with clinical data in 36.4% of cases (Pvalue<0.011) and with EMG in 45.9% of cases (Pvalue<0.0001), but this value between EMG and clinical data was 35.9% which was not statistically significant. As shown in Table 3, MRI, EMG and clinical findings have agreed in 14.6% of cases in determining of severity of radiculopathy (Figure 2).

As listed in Table 4 agreement of three methods to determine the involved nerve roots in radiculopathy is 26.7%.

Table 3. The frequency distribution of severity of radiculopathy based on EMG and MRI and clinical findings.

Severity of radiculopathy on MRI	Severity of radiculopathy on clinical findings				Total
	No	Mild	Moderate	severe	
No					
Severity of radiculopathy on EMG					
No	2	19	0	0	21
Mild	15	13	5	2	35
Moderate	2	2	4	0	8
Total	19	34	9	2	64
Mild					
Severity of radiculopathy on EMG					
No	25	57	0		82
Mild	77	62	15		154
Moderate	4	14	0		18
Sever	0	3	0		3
Total	106	136	15		257
Moderate					
Severity of radiculopathy on EMG					
No	13	9	5	0	27
Mild	25	44	19	0	88
Moderate	20	23	14	0	57
severe	0	4	2	2	8
Total	58	80	40	2	180
Severe					
Severity of radiculopathy on EMG					
No	0	0	3	0	3
Mild	0	5	0	0	5
Moderate	2	4	10	2	18
severe	3	2	12	2	19
Total	5	11	25	4	45

Table 4. The frequency distribution of radiculopathy level based on MRI, EMG and clinical findings.

Radiculopathy level on MRI	Radiculopathy level on clinical findings				Total
	No	L4	L5	S1	
No					
Radiculopathy level on EMG					
No	2		10	8	20
L5	13		6	0	19
S1	4		0	20	24
Total	19		16	28	63
L4					
Radiculopathy level on EMG					
No	16	4	10	0	30
L4	16	5	6	0	27
L5	21	0	34	2	57
S1	7	0	0	0	7
Total	60	9	50	2	121
L5					
Radiculopathy level on EMG					
No	13	0	27	15	55
L4	0	0	2	0	2
L5	62	2	90	10	164
S1	8	0	0	35	43
Total	83	2	119	60	264
S1					
Radiculopathy level on EMG					
No	10			20	30
S1	19			49	68
Total	29			69	98

Comparison between results of clinical findings and EMG for determination of radiculopathy level shows agreement in 51.3% of cases (Pvalue<0.0001). This value is 51.1% (Pvalue<0.0001) between EMG and MRI and 39.6% (Pvalue<0.0001) between MRI and clinical findings (Figure 3).

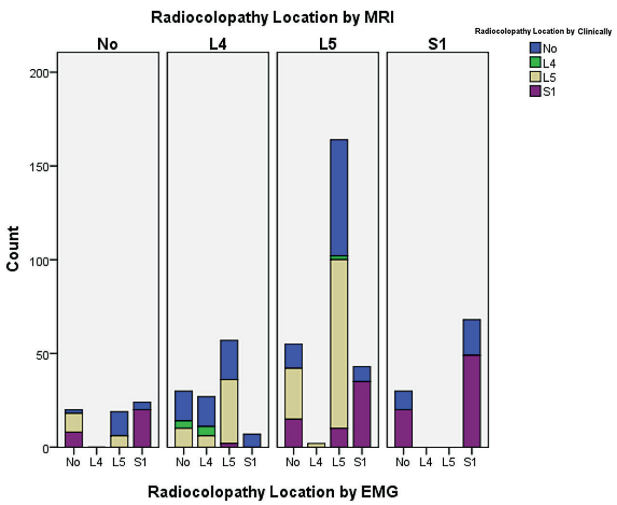

Figure 3. The frequency distribution of radiculopathy level based on MRI, EMG and clinical findings.

DISCUSSION

For any patient with low back pain if appropriate diagnosis was made, efficient treatment could be indicated[13]. Imaging instruments like MRI can show evidence of abnormal anatomical changes which can also be found in healthy and asymptomatic individuals. Thus both of clinical findings and imaging data are necessary for an appropriate approach to patients[14].

Electrodiagnostic methods including EMG have shown to be more accurate in assessment of physiological and functional status of the peripheral nervous system than assessing structural and anatomical abnormalities. Thus this technique could be useful in investigating the pathophysiology of the pain which can be used in selection of best treatment option. Electrodiagnostic tests have a complimentary role in diagnosis of low back pain and they should be used in presence of clinical evidence of probable nerve root damage. They can be used in identifying and quantifying neuropsychological abnormalities such as lumbosacral radiculopathies, plexopathies and peripheral nerve damage, as well[13].

In this study, 384 patients with low back pain have been studied in terms of presence of radiculopathy, its severity and involved nerve root causing patient's symptoms using three methods of diagnosis including EMG, MRI and physical examination. Three methods of radiculopathy diagnosis have been evaluated in terms of their agreement regarding diagnosis of radiculopathy as well as its severity and involved nerve root. In this study we showed that EMG and MRI could be used instead of each other whether in terms of diagnosis or severity and location of radiculopathy.

According to a study by Lee JH, et al although MRI and EDX are valuable diagnostic tools in radiculopathies. However, they are considered to be independent of each other meaning that each of these tools evaluate different factors of radiculopathy[15]. There are also some studies reporting different diagnostic capabilities of EMG and MRI. These results are in contrast with our findings in which EMG and MRI agreed in 76.8% of cases which was statistically significant meaning that both MRI and EMG could be valuable without considering different proficiency of both tests[16, 17].

In current study, clinical examinations and MRI agreed in 69.7% of cases which was not statistically significant. Bartinski reported that MRI and clinic are consistent with each other in most of the cases[14]. These findings again contrasts with our results in which we found no statistically significant agreement between the two methods. However our results could show that MRI and clinic might be

complimentary to each other in diagnose of radiculopathy.

In our results EMG and clinic had 62.7% agreement (40% disagreement) in diagnosis of radiculopathy which was not statistically significant. Although the level of disagreement was much more compared to Sizerini's study in which EMG and clinic had only 20% disagreement with each other, these findings suggest that both of these methods should be used in proper diagnosis of radiculopathy[17]. It can be understood from above findings that for an appropriate approach for diagnose of radiculopathy all three tests should be applied.

In our study there was 39.5% agreement between EMG and physical examination in grading severity of radiculopathy which was not statistically significant. Agreement between MRI and physical examination was 36.4% that was proven to be statistically significant. There was 45.9% consistency between EMG and MRI being statistically significant. On the other hand three above mentioned methods have only 14.9% agreement together. We think that positive point of our study is studying severity of radiculopathy in addition to determining the location and extent of agreement among three methods of diagnosis in radiculopathy. Our study shows that MRI and EMG should be concerned beside physical exam in determining the severity of radiculopathy and physical exam alone does not notably help detecting severity.

In order to point out level of consistency among three methods in detecting location of radiculopathy, 546 sensory nerve roots were studied. EMG and physical exam had 51.3% agreement and MRI compared to physical exam had 39.6% consistency in addressing location of radiculopathy. MRI had 51.1% agreement with EMG in detection of location of radiculopathy whereas three diagnostic tests had 26.7% consistency together. The level of agreement between MRI and EMG was almost similar to EMG and physical exam but MRI and physical exam had less level of concordance compared to other two pairs. According to Lee et al study EMG could have more clinical conformity in pointing location of radiculopathy by evaluating functional status of muscles[16] but our results show that EMG can be used instead of MRI in determining impaired sensory nerve root.

In our study we were unable to compare test results with the gold standard method which was surgery. Also we did not use more statistical methods. It is suggested that future studies apply above mentioned points in order to address the study defects.

CONCLUSION

Our study results showed that MRI is the best diagnostic tool for evaluating the presence of radiculopathy but EMG could also be used instead of MRI in radiculopathy diagnosis. Since EMG is more invasive than MRI, EMG is better to be considered as a second diagnostic tool. In measuring severity since there is no statistically significant concordance among the tests, all three tests could be used. In addition our study showed that MRI alone could be used in measuring radiculopathy severity. In determining involved sensory root the level of agreement between MRI with EMG compared to EMG and clinic was almost similar but MRI and clinic had low concordance with each other, meaning that although EMG is an invasive method of testing, due to its higher level of accuracy it can be used instead of MRI in pointing out location of radiculopathy. Our result showed that MRI alone could be used in measuring radiculopathy severity, as well.

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