Relationship Of Electromyography And Magnetic Resonance Imaging Findings With The Therapeutic Decision In Patients Diagnosed With Cervical Radiculopathy

Electromyography and Magnetic Resonance Imaging in cervical radiculopathy

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Abstract

Introduction- Magnetic Resonance Imaging (MRI) and Electromyography (EMG) have been evaluated with clinical findings in radiculopathy, showing a 60% coincidence between both, the relationship decreases significantly as the clinical syndrome becomes less reliable which makes the final therapeutic decision more complicated.

Objective. To determine the relationship between electromyography and magnetic resonance imaging findings and the therapeutic decision in patients with a diagnosis of cervical radiculopathy.

Material and methods. An observational, retroelective and descriptive study was performed. Patient records with a diagnosis of cervical radiculopathy from 2014 to 2019 were included. Statistical analysis was performed with the SPSS v19 program.

Results. Of 80 files, 82.5% (66 cases) were women and 17.5% (14 cases) were men. The mean age was 55.13±12.77 years. Eighty-two-point five percent were treated conservatively, while 17.5% received surgical management. Both studies were positive in 53.8% (43 cases) and negative in 6.2% (5 cases). 71.25% (57 cases) were obese/overweight.

Conclusions. Electromyography study and magnetic resonance imaging study were found to be complementary tests for diagnosis and therapeutic decision in patients with cervical radiculopathy.

Keywords: Electromyography, magnetic resonance imaging, radiculopathy, cervical, treatment, obesity.

INTRODUCTION

Magnetic resonance imaging (MRI) is the study of choice in the evaluation of radiculopathy, while needle electromyography (EMG) remains the mainstay of electrodiagnostic evaluation. Both provide relevant but different information regarding pathology and yet both procedures have inherent limitations. Making the final therapeutic decision more complicated.

Cervical radiculopathy.

It is a neurological condition characterized by objective signs of cervical spinal nerve dysfunction, nerve roots or both [1,2]. The severity of nerve root injury depends on the amount and duration of compression resulting in this sequence of events:

nerve distortion, intraneural edema, altered microcirculation leading to focal nerve ischemia, localized intraneural and connective tissue inflammatory reaction, and, finally, impaired nerve conduction. With sufficient compression of the root, axon loss occurs [3].

The most frequent sites of compression or damage are in the areas of the spine with greater mobility; C5-C6, C6-C7, with the most frequently affected nerve root being C7 (31-81%), followed by C6 (19%-25%), C5 (2%-14%)and C8 (4%-12%) [4-7].

There are no universally accepted criteria for diagnosis. In most cases, the clinical history and physical examination of the patient are the first step in making a diagnosis [4,8].

IMAGING STUDIES.

Plain radiography is generally the first to be requested in the anteroposterior and lateral views, however, it is of little use [8,9,10]. Computed tomography (CT) can be considered as the initial study to confirm a compressive lesion, if there is any contraindication to perform an MRI. CT myelography provides images similar and in some cases even superior to MRI, however, the latter is invasive in nature. MRI is the study of choice [8,9,10], which is a non-invasive method and without exposure to ionizing radiation [2]. Currently there are no guidelines that dictate its use in patients with radiculopathy, however, every person with symptoms of myelopathy (progressive neurological deficit) should undergo this study, in cases where these symptoms are absent, and the study can be deferred and performed in those who persist or do not improve after 4-6 weeks of treatment. This is due to the high frequency of alterations in the spine that are detected by this method in asymptomatic patients, which means a high rate of false positives (disc herniation in 57% of asymptomatic individuals) [9,10].

MRI has largely replaced computed tomography (CT) as the diagnostic modality in the evaluation of radiculopathy, while needle electromyography (EMG) remains the mainstay of electrodiagnostic evaluation. EMG provides a measure of the physiological integrity of the nerve roots, while MRI provides structural detail of the nerve roots and surrounding structures; however, both procedures have inherent limitations [11].

ELECTRODIAGNOSTIC STUDY.

It has a critical role in the evaluation of patients with symptoms and signs of cervical radiculopathy, has a modest sensitivity (50 to 71%) but high specificity. It is useful to confirm the pathology, locate the area of the lesion, determine the number of roots involved, differentiate the type of damage in multiple roots (axonal loss or conduction block), degree of severity, time of evolution and exclude other peripheral nerve pathologies [2,3,12,13].

TREATMENT

The main goal of the treatment is to relieve pain, improve neurological function and prevent recurrences. The patients are initially treated with analgesics. Conservative treatment includes certain therapeutic applications such as traction, manipulation/mobilization, therapeutic exercises, electrophysical agents, medication, and cervical steroid injection, among others. These have good to excellent results in up to 90% of patients [8,4].

For surgical treatment there is no clearly established consensus regarding its indications, intervention is suggested mainly for the rapid relief of symptoms caused by degenerative alterations, compared to medical or interventional treatment, another frequent indication for surgery is poor quality of life which is difficult to evaluate [15,16].

BACKGROUND

Over time these modalities have been evaluated first with clinical findings, where Nardin et al. in 1999 [11] found, in a small group of patients with cervical and lumbosacral radiculopathy, a 60% agreement between both studies. In the cervical radiculopathy group, there were 14 with significant findings on EMG and 13 on MRI, the agreement was higher in patients with abnormal findings on neurological examination and decreased significantly as the clinical syndrome became less reliable, these data agreed with the study of Nardin et al. [17], there was significant agreement only between clinical findings and MRI, but not between clinical findings and electrodiagnostic study [12].

Subsequently in 2002, Ashkan et al. [18] compared the results of preoperative EMG and MRI with postoperative findings and reported a sensitivity for MRI of 93% and for EMG of 42%, with positive predictive values of 91% and 86%, respectively. Concluding that, in patients with clinical evidence and MRI findings, EMG has limited additional diagnostic value but in 2007 Mogdad et al. [19], suggest that the best candidates for surgery are likely to be those with a positive needle EMG examination and that EMG is a valuable tool in the selection of patients likely to experience a better postoperative outcome.

Therefore, this study aims to verify the relationship between these diagnostic aids and the selected treatment, recognizing the information provided by each one to guide the therapeutic decision and to prove that it is important to perform the electrodiagnostic study.

MATERIALS AND METHODS:

An observational, retroelective and descriptive study was performed. A confidentiality letter was signed for the handling of the data in the file, and those with a clinical diagnosis of cervical radiculopathy performed by specialists in spine rehabilitation and spine surgery in the period from 2014 to 2019 at the Instituto Nacional de Rehabilitación ¨Luis Guillermo Ibarra Ibarra" (INR-LGII, Mexico City) were reviewed and included. Subsequently, a database was obtained with the review of the cervical spine nuclear magnetic resonance study and the electrodiagnostic study (performed and interpreted by physicians specialized in the area). Finally, the data necessary for the study were collected and recorded in an Excel format.

Measures of central tendency, dispersion and distribution were determined. Frequencies and percentages were calculated and Student's t-tests, concordance, Chi-square and the ANOVA test were applied. Statistical analysis was performed with SPSS v19. A value of $p<0.05$ was considered as statistical significant.

RESULTS:

A total of 4988 patient records were included, of which 138 had a clinical diagnosis of cervical radiculopathy and 80 met the inclusion criteria. Eighty-two-point five percent (66 cases) were women and 17.5% (14 cases) were men. The mean age was 55.13±12.77 years, with a minimum of 23 and a maximum of 80 years, with no difference in age in relation to sex (p=0.77). 71.25% (57 cases) were obese/overweight. Of which, 52.6% (30/57 cases) were overweight, 36.8% (21/57 cases) had obesity grade I, 5.3% (3/57 cases) had obesity grade II and III respectively.

Eighty-two-point five percent (66 cases) were treated conservatively, while 17.5% (14 cases) received surgical management. Table 1 shows the relationship between the type of treatment and the sex of the patients($p<0.05$).

Table 1. Relationship between type of treatment and sex of the patients.

Chi-square, p= 0.006		Sex		
		Male (n=14)	Female (n=66)	Total (N=80)
Type of treatment	Conservative	57.1% (8)	87.9% (58)	82.5% (66)
	Surgical	42.9% (6)	12.1% (8)	17.5% (14)

Mean age was different in relation to treatment (p=0.04). Patients treated surgically had a lower average age than those who received conservative treatment (53±12 years vs 61±10 years). No significant differences were observed between patients' average BMI and their management (p>0.05).

The electromyography study diagnosed 83.8% (67 cases) with an error of 16.2% (13 cases), the MRI diagnosed 63.7% (51 cases) with an error of 36.3% (29 cases). In the parallel analysis, both studies were diagnosed as positive for cervical radiculopathy in 53.8% (43 cases) and both were negative in 6.2% (5 cases).

The results of electromyography as a diagnostic test for cervical radiculopathy in relation to magnetic resonance imaging showed a sensitivity of 84% and a specificity of 17.24%. 53.75% (43/80 cases) were true positives, 6.25% (5/80 cases) true negatives, 30% (24/80 cases) were false positives and 10% (8/80 cases) were false negatives.

The concordance between EMG and MRI for the C5 root was 1.25% (1 case), for the C5-C6 roots it was 6.25% (5 cases), for C5-C6-C7 and C5-C6-C7-C7-C8 it was 2.5% (2 cases for each set), for C6-C7-C8 1.25% (1 case) and for patients without evidence of lesion they agreed in 6.25% (5 cases) (Kappa=0.06, p=0.14).

Conservative treatment is the most frequently used. In patients with a positive EMG result, management was surgical in 78.5% in relation to those with a negative EMG result (Table 2).

Table 2. Relationship between EMG diagnosis and type of treatment in patients with cervical radiculopathy.

Chi-square, p=0.40		Type of treatment		
		Conservative (n=66)	Surgical (n=14)	Total (N=80)
EMG diagnosis	Positive	83.6 % (56)	16.4% (11)	100% (67)
	Negative	76.9% (10)	23.1% (3)	100% (13)

EMG=Electromyography

The relationship between the MRI diagnosis and the type of management applied to the patients shows that conservative treatment is the most frequently used; in the case of surgical treatment, this was performed more frequently in patients diagnosed as positive by MRI (Table 3).

Table 3. Relationship between MRI diagnosis and type of treatment in patients with cervical radiculopathy.

Chi-square, p=0.01		MRI diagnosis		
		Conservative (n=66)	Surgical (n=14)	Total (N=80)
MRI diagnosis	Positive	74.5% (38)	25.5 %(13)	100% (51)
	Negative	96.6 % (28)	3.4 % (1)	100% (29)

MRI= Magnetic Resonance Imaging

The relationship between the level of affected root according to the EMG study and MRI with the WHO BMI classification showed an increase in the number of affected roots with a higher degree of obesity (Table 4 and Table 5).

Table 4. Relationship between the affected root level according to the EMG study and the WHOBMI classification.

	P> 0.05	normal weight % (n=23)	Overweight % (n=30)	Obesity Grade I % (n=21)	Obesity Grade II % (n=3)	Obesity Grade III % (n=3)	Total %(n=80)
Root level affected	C5	4.3 (1)	3.3 (1)	0	0	0	2.5 (2)
	C5-C6	17.4 (4)	23.3 (7)	14.3 (3)	0	0	17.5 (14)
	C5-C6-C7	13.0 (3)	6.7 (2)	14.3 (3)	33.3 (1)	33.3 (1)	12.5 (10)
	C5-C6-C7-C8	13.0 (3)	10.0 (3)	14.3 (3)	0	33.3 (1)	12.5 (10)
	C5-C7	4.3 (1)	0	0	0	0	1.3 (1)
	C5-C7-C8	0	3.3 (1)	0	0	0	1.3 (1)
	C6	4.3 (1)	3.3 (1)	9.5 (2)	33.3 (1)	0	6.3 (5)
	C6-C7	21.7 (5)	3.3 (1)	14.3 (3)	0	33.3 (1)	12.5 (10)
	C6-C7-C8	13.0 (3)	6.7 (2)	14.3 (3)	33.3 (1)	0	11.3 (9)
	C7	0	0	9.5 (2)	0	0	2.5 (2)
	C7-C8	0	10.0 (3)	0	0	0	3.8 (3)
	No injury	8.7 (2)	30.0 (9)	9.5 (2)	0	0	16.3 (13)

EMG=Electromyography

Table 5. Table 5. Relationship between the level of root affects evaluated by MRI and the classification of BMI according to the WHO.

	P> 0.05	Normal weight % (n=23)	Overweight % (n=30)	Obesity Grade I % (n=21)	Obesity Grade II % (n=3)	Obesity Grade III % (n=3)	Total % (n=80)
Root level affected	C5	8.7 (2)	3.3 (1)	0	0	0)	3.8 (3)
	C5-C6	17.4 (4)	23.3 (7)	23.8 (5)	0	0	20.0 (16)
	C5-C6-C7	8.7 (2)	13.3 (4)	23.8 (5)	33.3 (1)	0	15.0 (12)
	C5-C6-C7-C8	4.3 (1)	3.3 (1)	0	0	33.3 (1)	3.8 (3)
	C5-C7	0	3.3 (1)	0	0	0	1.3 (1)
	C6	4.3 (1)	10.0 (3)	4.8 (1)	0	0	6.3 (5)
	C6-C7	4.3 (1)	10.0 (3)	4.8 (1)	66.7 (2)	0	8.8 (7)
	C6-C7-C8	0	0	4.8 (1)	0	0	1.3 (1)
	C7	4.3 (1)	0	4.8 (1)	0	0	2.5 (2)
	No injury	47.8 (11)	30.0 (10)	33.3 (7)	0	66.7 (2)	37.5 (30)

MRI = Magnetic Resonance Imaging.

The result of EMG and MRI show higher frequency of conservative management when roots C5-C6 are affected and surgical management when the following sets of roots C5-C6 and C5-C6-C7 are involved (Table 6).

Table 6. Relationship of the root level affected by EMG and MRI with the type of treatmentreceived.

	p=0.72	Type of treatment		p=0.34	Type of treatment	
		Conservative % (n=66)	Surgical % (n=14)		Conservative % (n=66)	Surgical % (n=14)
Level of affected root evaluated by EMG	C5	1.5 (1)	7.1 (1)	Level of affected root evaluated by MRI	3.0 (2)	7.1 (1)
	C5-C6	16.7 (11)	21.4 (3)		18.2 (12)	28.6 (4)
	C5-C6-C7	10.6 (7)	21.4 (3)		12.1 (8)	28.6 (4)
	C5-C6-C7-C8	12.1 (8)	14.3 (2)		4.5 (3)	0
	C5-C7	1.5 (1)	0		0	7.1 (1)
	C5-C7-C8	1.5 (1)	0		0	0
	C6	6.1 (4)	7.1 (1)		6.1 (4)	7.1 (1)
	C6-C7	15.2 (10)	0		9.1 (6)	7.1 (1)
	C6-C7-C8	13.6 (9)	0		1.5 (1)	0
	C7	1.5 (1)	7.1 (1)		3.0 (2)	0
	C7-C8	4.5 (3)	0		0	0
	No injury	15.2 (10)	21.4 (3)		42.4 (28)	14.3 (2)

EMG= Electromyography, MRI= Magnetic Resonance Imaging.

Conservative treatment is used more frequently when 2 and 3 levels are affected as diagnosed by EMG, but surgical management is performed regardless of the number of affected roots evaluated by EMG. While for MRI conservative management is more frequent when there is no lesion and surgical management when 2 or 3 levels are affected (Table 7).

Table 7. Relationship between the type of treatment and the number of affected levels evaluated byEMG and MRI.

p= 0.58		Type of treatment		p=0.09		Type of treatment	
		Conservative % (n=66)	Surgical % (n=14)			Conservative (n=66)	Surgical (n=14)
Number of affected levels evaluated by EMG	0	15.2 (10)	21.4 (3)	Number of affected levels evaluated by NMR	0	42.4 (28)	7.1 (1)
	1	9.1 (6)	21.4 (3)		1	12.1 (8)	21.4 (3)
		37.9 (25)	21.4 (3)			27.3 (18)	42.9 (6)
		25.8 (17)	21.4 (3)			13.6 (9)	28.6 (4)
		12.1 (8)	14.3 (2)			4.5 (3)	0

EMG= Electromyography, MRI= Magnetic Resonance Imaging.

The EMG evaluation shows a higher frequency of involvement in the set of roots C5-C6-C7-C8 in men and C5-C6 in women. While by MRI the set of roots in men is C5-C6-C7 and in women is C5-C6. In women, EMG and MRI report higher frequency in the same affected root level. The EMG evaluation shows a higher frequency of involvement of 1 and 3 root levels in men and 2 in women. While MRI shows 3 levels of roots in men and no lesion is more frequent in women.

DISCUSSION:

In the present study we analyze the relationship between EMG and MRI with the therapeutic decision in patients with cervical radiculopathy in the INR-LGII from 2014 to 2019. Taking into account that both studies provide relevant information for the diagnosis and therapeutic decision, whether conservative or surgical treatment, we found that in previous works [20-22] there are some differences in the form and time for the application of one or the other study to patients with this pathology. We know that both studies present certain limitations, which has caused uncertainty in the final therapeutic decision [23,24]. Our results obtained from the population that attended the INR-LGII in the period show relevant data that lead us to recapitulate this type of decision.

There was a study universe of 4988 patient records that were evaluated in the spine rehabilitation and orthopedic spine consultation, of which 138 had a clinical diagnosis of cervical radiculopathy, but only 80 met the inclusion criteria. It is noteworthy that previous epidemiological studies on cervical radiculopathy reported an annual incidence rate of 107.3 per hundred thousand for men and 63.5 per hundred thousand for women, with a higher frequency between 50 and 54 years of age [2,4,8].

In contrast, in the present study we found that 82.5% were women and 17.5% men. The mean age was 55.13±12.77 years, with a minimum of 23 and a maximum of 80 years, with no difference in age in relation to sex (p=0.77), which is consistent with that reported in previous studies.

The contribution of this work was to consider the body mass index, to see how this variable could affect this pathology and we found that 71.25% had obesity/overweight. Of these, 52.6% were overweight, 36.8% had grade I obesity, and 5.3% had grade II and III obesity, respectively. This data is relevant considering that few studies have evaluated the relationship between fatty infiltration in the cervical multifidus muscle and patients with radiculopathy, since this type of radiculopathy is closely related to compressive and non-compressive factors [25,26].

It has been mentioned in the literature that the indications for the use of conservative or surgical treatment modality are currently unknown [7-29]. Our results showed that conservative treatment has been the most widely used and that surgically treated patients presented a higher average age than those who received conservative treatment (53±12 years vs 61±10 years). However, reviewing the background, we found that there is controversy regarding the treatment to be followed.

Some suggest that conservative treatment is the most adequate for the patient with cervical radiculopathy, this includes certain therapeutic applications such as traction, manipulation/mobilization, therapeutic exercises, electrophysical agents, medication, and cervical steroid injection, among others. These have good to excellent results in up to 90% of patients [8,14], while the use of oral analgesics and non-steroidal anti-inflammatory drugs (NSAIDs) has been proposed. Oral corticosteroids are sometimes used in the acute phase; however, there is no evidence to support the efficacy of this indication. Although the use of epidural corticosteroid injections has scarce evidence [8,20].

On the other hand, for surgical treatment there is no clearly established consensus regarding its indications; intervention is suggested mainly for the rapid relief of symptoms originated by degenerative alterations, in comparison with medical or interventional treatment; another frequent indication for surgery is the poor quality of life, which is difficult to evaluate [15,16]. It is undeniable and important to look for a quick and adequate clinical solution for the patient, but in the eagerness to find this solution, sometimes direct clinical observations are omitted, which lead us to an early diagnosis of radiculopathy. The clinical history is a critical point, because a large number of differential diagnoses must be considered. On the one hand, the EMG study diagnosed 83.8% of the study population with an error of 16.2%. As for MRI, 63.7% were diagnosed with an error of 36.3%.

In the parallel analysis, both studies were diagnosed as positive for cervical radiculopathy in 53.8% and both negative in 6.2%, which demonstrates the importance of the application of both tests to confirm the diagnosis. However, the statistical analysis of our data showed a sensitivity of 84% and a specificity of 17.24%, with a predictive value of 64.81%. The high sensitivity and specificity obtained

shows that the use of EMG and MRI are closely related and that both should be applied to obtain a more accurate diagnosis.

Now, by identifying the number of cervical roots affected and the relationship that exists with the patient's body mass index. Our data showed an association between the level of the affected root according to the EMG result with the WHO BMI classification. In Normal weight the lesion in roots C6-C7 was more frequent simultaneously, in overweight people it was C5-C6, in obesity grade I there is lesion of C5-C6, C5-C6-C7, C6-C7 and C6-C7-C8 in the same percentage, in obesity grade II C5-C6-C7, C6 and C6-C7-C8 in the same percentage and in obesity grade III the set of roots C5-C6-C7-C7, C5-C6-C7-C7-C8 and C6-C7 are reported in the same frequency. The number of affected roots increases with higher degree of obesity.

Our results are consistent with the literature, where it was reported that the most frequent compression or damage sites are in the areas of the spine with greater mobility; C5-C6, C6-C7, with the most frequently affected nerve root being C7 (31-81%), followed by C6 (19%-25%), C5 (2%-14%) and C8 (4%-12%) [4,7].

Now, regarding treatment, the EMG and MRI results show a higher frequency of conservative management when roots C5-C6 are affected and surgical management when the following sets of roots C5-C6 and C5- C6-C7 are involved. Conservative treatment is used more frequently when 2 and 3 levels are affected, but surgical management is performed regardless of the number of affected roots evaluated by EMG. While for MRI, conservative management is more frequent when there is no lesion and surgical management when 2 or 3 levels are affected. This leads us to suggest that the therapeutic decision, in this study, is based more on the result of the MRI test. It has already been reported that the initial physical examination includes observation to detect muscle atrophy which is mainly present in severe or chronic lesions and may suggest the involvement of a nerve root [8].

Other contributions of the present study are; the evaluation by EMG that shows greater frequency in the set of roots C5-C6-C7-C8 in men and C5- C6 in women. While by MRI the set of roots in men is C5-C6-C7 and in women it is C5-C6. In women, EMG and MRI report higher frequency in the same affected root level. The EMG evaluation shows a higher frequency of involvement of 1 and 3 root levels in men and 2 in women. While MRI shows 3 levels of roots in men and no lesion is more frequent inwomen.

It is worth mentioning that the addition of the BMI variable has provided us with a broader view of the effects of this variable on the population studied with cervical radiculopathy, providing us with more information about the damage and affectation that different degrees of obesity have on cervical radiculopathy.

Based on the results obtained, we were able to confirm the importance of the application of EMG and MRI to patients diagnosed with cervical radiculopathy, taking as a basis the clinical evaluation through the patientsrecords.

The description of the usefulness of these tests in the detection and diagnosis of this pathology is based on their high sensitivity, specificity, positive and negative predictive value. It is important to consider that radiculopathy or polyradiculopathy can occur without a structural lesion seen on MRI or CT myelography, but if detected by EMG in 3 out of 10 patients that is not detected by MRI.

Since the electrodiagnostic information and the clinical and physical history and MRI findings combine to confirm the most likely diagnosis and guide future treatment. All of this becomes vitally important in surgical planning, ifrequired by the patient.

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